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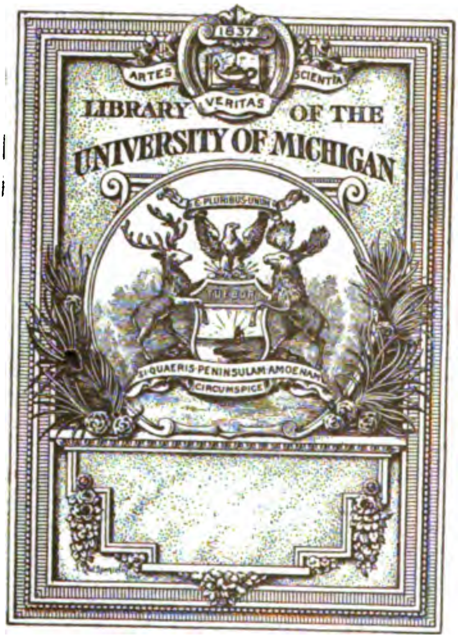
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(Continued on third page of cover.)

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[a] Transferred, August 16, 1902, to the U. S. Public Health and Marine-Hospital Service, as Chief of Division of Zoology, but remains also in temporary charge of Zoological Division, Bureau of Animal Industry.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 47.
D. E. SALMON, D. V. M., Chief of Bureau.

THE HOG INDUSTR

SELECTION, FEEDING, AND MANAGEMENT.
RECENT AMERICAN EXPERIMENTAL WORK.
STATISTICS OF PRODUCTION AND TRADE.

BY

GEORGE M. ROMMEL, B. S. A.,
EXPERT IN ANIMAL HUSBANDRY, BUREAU OF ANIMAL INDUSTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 29, 1903.

SIR: I have the honor to transmit herewith the manuscript of an article entitled The Hog Industry: Selection, Feeding, and Management; Recent American Experimental Work; and Statistics of Production and Trade, by George M. Rommel, expert in animal husbandry, and to recommend the publication of the same as Bulletin No. 47 of this Bureau. In the compilation of the portion relating to American experimental work Mr. Rommel has consulted with Dr. C. F. Langworthy, of the Office of Experiment Stations, and in the preparation of that portion relating to statistics of production and trade in hogs, with the chief of the Bureau of Statistics, and for the valuable assistance thus obtained I desire to make acknowledgment. Our thanks are due Prof. Charles F. Curtiss, Director of the Iowa Experiment Station, for assistance.

The bulletin is a very comprehensive one, covering every phase of the subject, and it will be useful, it is believed, to the large number of persons engaged in the industry mentioned.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON, *Secretary.*

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SELECTION, FEEDING, AND MANAGEMENT.

THE HOG INDUSTRY.

By George M. Rommel, B. S. A.,
Expert in Animal Husbandry, Bureau of Animal Industry.

SELECTION, FEEDING, AND MANAGEMENT.

The hog has always occupied an important place in the animal husbandry of the United States. Unlike the supply of breeds of other kinds of live stock, the main dependence of American farmers for hogs has been placed upon breeds that have been developed on American soil. With a large native stock at hand, by selecting and feeding, blending strains and molding forms, American farmers may be said to have done for hogs what English farmers have done for the breeds of beef cattle and mutton sheep. Five distinct breeds have originated within that section of the country where corn is notably a feature in farming, viz, the Chester White in Pennsylvania, the Duroc Jersey in New Jersey and New York, the Poland China in Ohio and Illinois, the Victoria in New York and Indiana, and the Cheshire in New York. From the localities of their origin these breeds have been gradually disseminated over the entire country, the Poland China and Duroc Jersey having perhaps the widest distribution.

Coincident with the development of native breeds, the leading English breeds, particularly the Berkshire, have come into more or less popularity. The Berkshire has here the largest representation of foreign breeds, and are very nearly, if not quite, as generally distributed as the Poland China. With it have come the Essex (called Small Black, or Suffolk, in England),[a] the Large, Medium, and Small Yorkshire (generally called Large White, Middle White, and Small White in England),[b] and the Tamworth. A strain of white pigs known as Suffolks is somewhat general in this country, but good authorities consider it merely the Middle Yorkshire under another name. The real Suffolk pig is our Essex, in whose development Lord Western and Fisher Hobbs had so strong an influence.

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[a] Spencer. Pigs: Breeds and Management, p. 15.

[b] Idem, p. 5.

CONDITIONS SUITABLE FOR HOG RAISING.

The climate and soil which will best favor the production of any kind of live stock are those in which the same kind of stock is found wild. In his native state the hog frequents those localities where vegetation is abundant if not luxuriant. The climate is usually one of only moderate severity. If extremes either of heat or cold are common, the environment provides shelter in the dense thickets in winter and shade and an abundance of water in summer. He is a heavy and promiscuous feeder, and, therefore, in his domestic state he thrives best where pastures are most luxuriant and grain crops, nuts, or roots are most abundant. The hog is not a ranger, nor does he thrive on grass alone; he can not endure a great amount of travel at a time; exercise he must have, yet he must be able to find his feed with only a small amount of searching, and water should always be easily accessible. During hot weather he craves a pool of water to reduce his temperature, for he perspires little; and in winter he wants shelter from storms. Owing to these requirements there are few hogs in the semiarid States of the West, and in that section hog raising is coincident with irrigation and alfalfa growing.

The first place in hog raising in the United States is easily with the corn-growing sections, and here corn is the first grain thought of when the fattening of animals, especially hogs, is mentioned. It is, however, fallacious to argue that hog feeding will not give profitable returns outside of the corn belt. The corn belt has wonderful advantages for economical pork production, but it also has its disadvantages, one of which is the effect on fecundity of feeding too much corn to breeding stock. Any locality that will grow clover of any species, that is favorable to the production of alfalfa, peas, or beans, where grains are readily grown—not only corn, but barley, wheat, oats, or rye—will be a favorable situation for the successful production of pork. If it is a locality where dairying is common, no better advantages are required; for, given leguminous pasture—clover, alfalfa, peas, beans, etc.—as a basis, with a grain feed that can be readily grown and also dairy by-products, the very highest grade of pork can be produced at a minimum cost. Variety of feeds alone is an item of immense importance in feeding. An animal tires of a constant ration of one kind, and is more easily put "off feed" at such times than when he is occasionally supplied with a change to keep his appetite keen. Not only has variety of feed an influence on appetite, but it results in a better quality of pork.

The few States comprising the corn belt are in reality the source of supply for a great amount of the meat product, especially hams and bacon, that is consumed in other portions of the country. Yet the advantages of many of these corn-belt States are little, if at all, superior to those outside of that district. The South has an abundance of vegetation. Cowpeas, velvet beans, and peanuts are leguminous crops that are peculiar to that section. Corn grows readily in all parts of the South, and in the subtropical portions the experience of feeders with cassava seems to indicate that it has considerable value for pork production. In addition, there is generally an abundant water supply; the climate is mild, and there is a long period during which green feed is available; the expense of shelter and winter feeding is very greatly lessened. These conditions, giving a long period of pasture and outdoor life, enhance thrift, and, with proper management, insure great freedom from disease.

In the extreme West the alfalfa of the irrigated valleys and the clover of the coast districts give a splendid foundation for successful pork production. In most of these regions there is an abundance of small grain, particularly barley, that may often be fed economically, while in some localities corn is a successful crop.

Barley is of so much interest to the experimenter, and its use is of so great importance in the production of prime pork, that it demands more than a passing notice. This grain has not been relied upon to a great extent in America as the principal part of a hog-fattening ration, but the practice of Danish farmers and the results of experiments can very well be studied with profit by American feeders. The Danish bacon, which figures so prominently in the English markets, is produced mainly with barley and dairy by-products. At the Ontario Agricultural College, Day has found barley so valuable in the production of prime export bacon that it is now used as a standard with which other grains are compared. In his experiments to determine the nature and causes of "soft" pork, Shutt found that the best bacon produced was by a ration in which barley was at least one-third of the whole amount. Farmers in those parts of the country where barley is a prominent crop can well devote attention to their opportunities for pork production; besides, in addition to this grain, some of the leguminous crops can often be grown for pasture, thus furnishing materials for a well-balanced ration.

The grain-growing districts of eastern Oregon and eastern Washington are instances of such localities. Corn is raised there to a very limited extent, but barley is an abundant crop and can be produced at minimum cost, and often wheat may be utilized. In nearly all parts of this section there are irrigated valleys where alfalfa grows abundantly. Yet every town and city in this section imports immense quantities of pork products from the corn belt; indeed, it has been stated that 75 to 90 per cent of all the hams and bacon sold at Spokane are shipped in from the East; and when one remembers that this city feeds a very great territory it is readily seen how great is the dependence on the corn belt.

The purpose of these remarks is not to minimize the value of corn in meat production of any kind. Corn is, perhaps, with a favorable climate and soil, the most economical grain that is at the command of the stock raiser and feeder of the United States. It is nutritious and highly palatable. Without its use it is difficult to imagine how the animal products of the United States could have attained their present position in the world's commerce; and so long as meat products are a factor of American agriculture, corn will probably be a leading factor in meat production in this country, and the corn belt will naturally continue to be more or less the center of feeding operations. On the other hand, the condition is ever present that farmers in localities where corn is a limited product have their own wants to supply. If, in addition to their own needs, the farmers of these localities can supply a share of the export demand, great strides will have been taken in their agricultural development; for "live-stock husbandry is the foundation of successful agriculture." A market for the surplus is, of course, essential, but where a supply is available the market will probably grow up. The condition of the meat trade at present indicates that a strong market is assured for a very considerable time to come. The statistics presented herein show generally an increased trade both at home and abroad. The domestic consumption of all kinds of meats seems to be increasing, although the per capita amount can not be shown with accuracy. There is little reason to fear that the further development of the pork-producing interests of the United States will soon result in overproduction.

THE PROFITABLENESS OF HOG RAISING.

FECUNDITY.

The first feature of hog raising that appeals to farmers is the fecundity of the sows. No other meat-producing domestic animal, after poultry, is capable of producing so large a number of young in a year. The size of litters varies with breeds and with location and feed.

One of the effects of high corn feeding on breeding stock is the lessening of prepotency and fecundity. When the conditions of forage furnish a more or less varied diet, and consequently a better balanced ration, high fecundity may be expected. Free access to pasture will therefore always be a good practice with breeding sows. In addition to this, the number of hogs may almost be doubled by breeding the sows so as to produce two litters a year. The practice demands considerably more care on the part of the breeder than when breeding but once a year, and it should not be attempted unless the needed attention can be given at farrowing.

CHEAPNESS OF PRODUCTION.

Lawes and Gilbert[a] were the first investigators to make accurate determinations of the relative economy of meat production from the various domestic animals. The summary of their studies on this subject is as follows:

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[a] "On the composition of oxen, sheep, and pigs, and their increase whilst fattening," pp. 53-54.

(1) Fattening oxen, fed liberally upon good food, composed of a moderate proportion of cake and corn, some hay or straw chaff, with roots or other succulent food, and well managed, will on the average consume from 12 to 13 pounds of the dry substance of such mixed food per 100 pounds live weight per week, and should give 1 pound of increase for 12 to 13 pounds of dry substance so consumed. Sheep fattening under somewhat similar circumstances, but with a less proportion of hay and straw, will consume about 15 pounds of the dry substance of the mixed foods per 100 pounds live weight per week, and should yield, over a considerable period of time, 1 part of increase in live weight for about 9 parts of the dry substance of their food. If the food be of good quality, oxen and sheep may give a maximum amount of increase for a given amount of total dry substance of food, even provided the latter contain as much as 5 parts of total nonnitrogenous to 1 of nitrogenous compound.

(2) Pigs fed liberally upon foods composed chiefly of corn will consume from 26 to 30 pounds per 100 pounds live weight per week of the dry substance of such food. They should yield 1 part of increase in live weight for 4 to 5 parts of the dry substance of the food. They may give a maximum amount of increase for a given amount of dry substance of such food if it contain as much as 5 or even 6 parts of total nonnitrogenous to 1 of nitrogenous compounds.

These results have been corroborated repeatedly by American experimenters.

In their dressed weight hogs show less variation than cattle and about the same as sheep. The range between young pigs or poorly fattened animals and mature, finished hogs will be about 8 per cent—approximately 74 to 82 per cent of the live weight; with cattle the range is at least 15 per cent, between 55 per cent in the lowest returns of ordinary market animals and the high records of 70 per cent and over with stock-show winners. Sheep will vary approximately, depending on the age and condition, from 48 to 60 per cent.

HOGS AS SCAVENGERS.

The third benefit to be derived by the farmer from raising hogs comes from their eating waste products that would otherwise become a nuisance. Kitchen slops, the screenings from fanning mills, and the waste from thrashing machines can all be utilized in the pig yard; while the use of hogs in connection with beef production is frequently regarded by feeders as the principal source of profit. If hogs are raised in connection with dairying, pork of the highest quality may be produced. Dairy by-products (skim milk, buttermilk, and whey) agree with hogs especially well. Skim milk is especially valuable for pigs before weaning and during the earlier stages of feeding after they are weaned. Its value with breeding stock is also very great. Whey is also valuable, though not so much so as skim milk. It should be fed carefully, for large amounts given continuously will cause a sort of rheumatic lameness in pigs.

Care must be taken in using hogs as scavengers. A good deal of stuff that finds its way to the hog lot should go to the garbage bank. Deleterious substances, such as lye, soap, glass, nails, etc., are very frequently in city swill, and such swill has been known to prove fatal when fed.

HOUSES, INCLOSURES, AND FENCES.

THE HOUSE AND ITS LOCATION.

Hogs are notably affected by extremes of heat and cold, and the character of their shelter will therefore depend on the locality. If the locality is one of severe winters, warm quarters are a necessity and an extensive piggery may be erected. Four things should be especially considered in its construction—(1) light, (2) ventilation, (3) warmth, and (4) cleanliness. Under cleanliness, ease of cleaning and dryness must be regarded. A well-drained location should be chosen. One that will give the hogs a good climb to reach it will provide needed exercise. The house should be on a north-and-south line, so that both sides may receive direct sunlight during a part of the day. Mr. John Cownie, of Iowa, recommends a house with a wide driveway, with pens 6 or 8 feet square on either side opening into the driveway, and each pen provided with a window for light and ventilation.[a] Mr. L. N. Bonham, of Ohio, recommends a house with a row of sleeping pens on either side of a cement-floored alley, opening into feed pens floored with cement. The sleeping pens are floored with boards laid in gravel or cinders. Paving brick cost about twice as much as cement.[b]

If no other means of ventilation than the windows are provided, they should be so arranged that entering air currents will be directed upward when the windows are opened and direct drafts on the hogs avoided. The size of the house and its equipment will depend upon the size of the herd and the resources of the owners. Not more than 50 breeding hogs should be confined in one house; sanitary considerations make a smaller number much safer. Out of doors the number of hogs in one inclosure may be increased considerably above 50 without danger.

Under any circumstances, the house should be well constructed and warm. If boarded up inside with good matched siding, such a house will be comfortable in zero weather and sows may farrow there with safety. Concrete or brick floors are expensive, but if the initial expense can be incurred and the floors are well laid, they will pay good interest in the saving of manure and the dryness of the house. Animals should not be compelled to sleep directly on such floors, for rheumatism and colds are very likely to result. The best floor for a sleeping or farrowing pen is one of wood on concrete, the wood being 2-by-4 timbers, laid from one-fourth to three-eighths inch apart to allow drainage. If not constructed in this way, concrete and brick floors should be kept well littered. A clay or ordinary earth floor is excellent, and by some preferred to any other. It is the warmest floor, but not so easily kept clean as one of brick or concrete. If a house is constructed with earth floors, care must be taken that they are well drained, both underground and on the surface. The greatest necessity for a good house is at farrowing time, for it is then that more pigs die than at any other. If the sow farrows in a damp or cold place or in drafts, serious results to the sow or the pigs or to both will follow. At this time the sow is seriously weakened and she is very susceptible to exposure, while new-born pigs are easily stunted or killed by chilling. Rheumatic complaints are common with pigs and are often caused by damp, chilly sleeping places.

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[a] Thirteenth Biennial Report of Kansas State Board of Agriculture, p. 695.

[b] Breeder's Gazette, February 18, 1903.

PORTABLE HOUSES.

The portable house is coming into very general favor, especially in disease-infested districts. They are of various forms and should be large enough for five or six grown hogs, with enough height to allow a man to stand erect; 6 by 6 feet or 8 by 8 feet are good sizes. Such houses should be strongly constructed of good lumber, with perfectly tight siding and roof. They are generally made without floors. If lined inside with the same materials as outside, such a house will be warm enough for a sow and pigs in zero weather.

A chief advantage of a portable house over the piggery system of several pens and a large number of hogs under one roof is its ease of management in times of epidemic. Only a few animals may be kept in one pen, and the isolation of the diseased animals when an outbreak begins is thus rendered comparatively easy. When cholera breaks out in a crowded piggery, every animal in the building is exposed, and the farmer, though he may isolate the unaffected animals at once, does not know how soon the second outbreak will occur; he has no check whatever on the epidemic. But with portable hog houses each house is itself a cholera check and only infection directly from diseased animals can spread the disease.

HOUSING IN MILD CLIMATES.

In the South and in much of the country west of the main chain of the Rocky Mountains the winters are sufficiently mild to obviate the necessity of constructing buildings of much warmth. Not only are the winters mild, but they are comparatively short, and green feed is available much longer than in other parts of the country. In such localities a shed will often suffice, but it should be well constructed in order to provide protection from storms and damp, chilly weather. The location, as that of a piggery, should be high and well drained, affording clean, dry sleeping places; the shed should open to the south. The expense of such a building is well warranted in view of the added comfort to the stock and increased number of pigs raised. Under all circumstances, regardless of climate, whether a man is breeding purebred stock or grades, hogs should have sleeping places that are dry and warm and feeding places that are clean.

PENS AND PASTURES.

The question of pens and pastures, both as to size and location, must be determined by each one for himself. Local conditions, expense, and convenience must be considered. A good rule to follow is to favor large inclosures rather than small ones. A number of pens and several pastures will be found a convenience and are particularly valuable when disease makes its appearance, as hogs affected may then be removed at once. A quarantine pen with an absolutely tight fence should be arranged on every farm where hogs are kept. Here all new-purchased hogs should be confined after arriving at the farm until all danger of infection is past.

It will generally be a satisfactory practice to keep hogs away from other stock, except when following fattening steers. Pregnant brood sows should never be allowed to run in the same yards or pastures with cattle, horses, or mules. Many good sows have been ruined by the playfulness or viciousness of the larger farm animals.

The pen and yard for the boar should be separate from the rest of the herd and out of sight of it. The pen should be so strong that the boar can not tear it down or go through it, and a tightly fenced pasture of one-half to 1 acre in area should adjoin.

A "down"[a] pigging sow, if she is to farrow in the piggery, can have the run of the alley for exercise. If she has a house to herself, a small yard should adjoin.

FENCING.

No man should attempt to raise hogs without adequate fencing of yards and pastures. An animal of any kind, but especially a hog, can make himself an intolerable nuisance if not confined within proper bounds. For pastures woven wire is the best fencing material, all things considered. Such a fence may be purchased ready-made or may be made on the farm by machines. There are several good kinds on the market. From motives of economy, it may be desired to run a fence of woven wire around a field to a height of 30 to 36 inches, and above this to stretch two or three strands of ordinary barb wire. This will make a hog-tight fence, and if horses are necessarily placed in the field the fence will be much safer than the ordinary one made entirely of barb wire. Midway between the posts the lower strand in the fence should be securely stapled to a small post or stake; this will prevent hogs from working their way under the fence. In building any kind of wire fence ground wires may be put down to moisture at frequent intervals to give stock protection from lightning.

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[a] A sow about to farrow.

A board fence makes, perhaps, the most secure inclosure for hogs, but its expense precludes its use generally except for yards and pens. These should always be of boards, stoutly nailed to strong, well-set posts.

Barb wire is very poor material for a hog fence. It can hardly be made close enough or strong enough to prevent a shoat from crawling through. In this respect it is only a little better than a hedge, which is expensive and unsatisfactory when used to confine stock. Gates must, of course, be carefully made, hung, and fastened.

SELECTION OF BREEDING STOCK.

THE BREED.

The question of breed, though agitated to a less extent at present than during ordinary years, is, nevertheless, complicated and will continue to be so as long as man eats meat. Each breed has its merits, and family attachments, personal preferences, and the influence of environment will never fail to create strong and healthy partisanship for each breed of established reputation. However, in actual practice, the man who feeds for the market recognizes, not breed, but type. His selections may be made promiscuously from among the available material, but all are required to conform to a certain standard, which, when fattened, is the hog demanded by the market; for with all meat-producing animals the stock that is fed for market must conform to market requirements to return a profit to the feeder. Therefore if they are to maintain their standing the breeds that produce these animals must be managed so that their produce will meet the market demands, and thus the market qualifications become the standard, not only for a few breeds, but for all. This is particularly noticeable in the case of the breeds of beef cattle and hogs.

SIMILARITY OF TYPE IN DIFFERENT BREEDS.

Among breeds of hogs, therefore, differences between the breeds will be noticed principally in details. For example, the advocates of one breed want a hog with a deeply dished face, a short nose, and an erect ear. Such are the Berkshire breeders. Breeders of Poland Chinas do not breed for so great a dish in the face nor for so short a nose, and usually take an ear that is "broken" about one-fourth its length from the tip. In their color requirements the breeders of both prefer black with six white points (feet, face, and brush of tail). Again, Duroc Jersey and Chester White breeding hogs show even closer similarity of individuals than Berkshires and Polands, but are readily distinguishable by the characteristic colors. But on the points that represent the real meat-yielding parts of the animals the standards are almost identical. Breeders look for quality, depth, length, and width of form and depth and condition of flesh, regardless of whether their hogs are black, red, or white.

At first sight breeds of the bacon type seem to be exceptions to this rule, but as yet there is not in the United States what can be called a general market class for hogs of this type. Packers explain this by saying that the scarcity of supplies of bacon hogs precludes their distinction as a separate market class. At present (1902) the hog that sells for the highest price on the markets of the central West is the hog of the lard type. Nevertheless, competent authorities are strongly of the opinion that the consumer's demand in the not far distant future will undergo a change and require a cut of pork that contains relatively more lean and less fat. If the public demand changes, the prices paid by packers will show a discrimination in favor of such an animal and the type will change. Such a transformation has taken place in the hog of England during the past twenty-five years; also in both England and America the highest type of steer demanded by the market has been changed from a huge fat 3-year-old, weighing up to 2,000 pounds, to the small handy-weight steer, weighing from 1,200 to 1,600 pounds. The possibility of a change in our hog type is apparent, but if it comes it will hardly result in supplanting any of the native breeds of this country. Their hold on the soil and the natural plasticity of conformation of the hog will cause American breeders to bring their standards to conform to market requirements. Prejudices will be cast aside, markets will be studied, rigid selection practiced. All animals that do not show the proper conformation will be eliminated from the breeding herd until the new conditions have been met. In any case the argument holds that the breed standards are molded by market qualifications and that the ideals of all breeds tend to converge into a common type.

How closely the breeds conform to a common standard may be seen by a perusal of the following comparative score card:

COMPARATIVE SCORE CARD OF FIVE BREEDS OF HOGS OF THE LARD TYPE.

[Compiled from the score cards of the National Association of Expert Judges on Swine.]

DETAILED DESCRIPTION.

HEAD.

Poland China.—Head broad, even, and smooth between and above the eyes; slightly dished, tapering evenly and gradually to near the end of the nose; inclined to shortness, but not enough to give the appearance of stubby nose; in male a masculine expression and appearance; broad lower jaw.

Berkshire.—Head short, broad, coming well forward at poll; face short and fine and well dished, broad between the eyes, tapering from eyes to point of nose, surface even and regular.

Duroc Jersey.—Head small in proportion to size of body, wide between eyes; face nicely dished (about half way between a Poland China and a Berkshire) and tapering well down to the nose, surface smooth and even.

Chester White.—Head short and wide; cheeks neat but not too full; jaws broad and strong; forehead medium, high, and wide; face short and smooth, wide between the eyes; nose neat and tapering and slightly dished.

Victoria.[a]—Head rather small and neat; face medium, dished, and smooth, wide between eyes, and tapering from eyes to nose.

Objections.

Poland China.—Head long and narrow between the eyes; nose uneven and coarse; too large at the muzzle or head too short; not full or high above the eyes or too much wrinkled around or above the eyes.

Berkshire.—Head long, narrow, and coarse; forehead low and narrow; jaws narrow or contracted; lower jaw extending beyond upper; face long and straight between eyes; nose coarse, thick, or crooked or ridgy.

Duroc Jersey.—Head large and coarse, narrow between the eyes; face straight; nose crooked or too much dished.

Chester White.—Head long, narrow, and coarse; forehead low and narrow; jaws contracted and weak; face long, narrow, and straight; nose coarse, clumsy, or dished like a Berkshire.

EYES.

Poland China.—Full, clear, prominent, and expressive.

Berkshire.—Very clear, rather large, dark hazel or gray.

Duroc Jersey.—Lively, bright, and prominent.

Chester White.—Large, bright, clear, and free from wrinkles of surrounding fat.

Victoria.—Medium size, prominent, bright, clear, and lively in young and of quiet expression in aged animals.

Objections.

Poland China.—Dull of expression, deep set, or obscure; sight impaired by wrinkles, fat, or other cause.

Berkshire.—Small, dull, bloodshot, deep set, or obscure; sight impaired by wrinkles, fat, or other causes.

Duroc Jersey.—Dull, weak, and obscure.

Chester White.—Small, deep, or obscure; sight impaired in any way.

EARS.

Poland China.—Ears attached to the head by a short, firm knuckle, giving free and easy action; standing up slightly from the base to within two-thirds of the tip, where a gentle break, or drop, should occur; in size neither too large nor too small, but even, fine, thin, leaf shape; slightly inclined outward.

Berkshire.—Generally almost erect, but sometimes inclined forward with advancing age; medium size, thin, and soft.

Duroc Jersey.—Medium, moderately thin, pointing forward, downward, and slightly outward, carrying a slight curve; attached to head very neatly.

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[a] The Victoria standard is that of the Victoria Swine Breeders' Association, but it has been adopted by the Association of Expert Judges for their use and is published along with their own score cards.

Chester White.—Medium size, not too thick, soft; attached to the head so as not to look clumsy; pointing forward and slightly outward; fully under control of the animal; drooping so as to give a graceful appearance.

Objections.

Poland China.—Large, floppy, straight, upright, or coarse; knuckle long, letting the ear drop too close to the head and face, hindering the animal in thei- free use.

Berkshire.—Large, coarse, thick, round, or drooping; long or large knuckle; difference in form or position from each other; animal unable to control their position.

Duroc Jersey.—Very large, nearly round, very thick, swinging, or flabby; not of same size; differing in position, and not under control of animal.

Chester White.—Large, upright, coarse, thick, round, too small, dropping too close to the face; animal unable to control them.

NECK.

Poland China.—Short, wide, even, smooth, well arched; rounding and full from poll to shoulder, with due regard to the characteristics of the sex.

Berkshire.—Full, deep, short, and slightly arched, broad on top, well connected with shoulder.

Duroc Jersey.—Short, thick, and very deep and slightly arching.

Chester White.—Wide, deep, short, and nicely arched.

Victoria.—Medium wide, deep, short, well arched, and full at top.

Objections.

Poland China.—Long, narrow, thin, and drooping from the shoulder to the poll, with unevenness caused by wrinkles or creases.

Berkshire.—Long, flat, lacking in fullness and depth.

Duroc Jersey.—Long, shallow, and thin.

Chester White.—Long, narrow, thin, flat on top, tucked up, not extending down to the breastbone.

JOWL.

Poland China.—Full, broad, deep, smooth, and firm, carrying fullness back near to point of shoulders, and below line of lower jaw, so that lower line will be as low as breastbone when head is carried up level.

Berkshire.—Full, firm, and neat, carrying fullness back to shoulder and brisket.

Duroc Jersey.—Broad, full, and neat, carrying fullness back to point of shoulders and on a line with breastbone.

Chester White.—Full, smooth, neat, and firm, carrying fullness back to shoulder and brisket when the head is carried up level.

Victoria.—Medium full, nicely rounded, neat, and free from loose, flabby fat.

Objections.

Poland China.—Light, flabby, thin, and wedge shaped; deeply wrinkled, not drooping below line of lower jaw, and not carrying fullness back to shoulder and brisket.

Berkshire.—Light, flabby, thin, tucked up or wrinkled.

Duroc Jersey.—Too large, loose, and flabby; small, thin, and wedging.

Chester White.—Light, too large and flabby, rough, and deeply wrinkled; not carrying fullness back to shoulder and brisket.

SHOULDERS.

Poland China.—Broad and oval at the top, showing evenness with the back and neck, with good width from the top to the bottom, and even smoothness, extending well forward.

Berkshire.—Broad, deep, and full; not extended above line of back, and as wide on top as back, carrying size down to line of belly, and having lateral width.

Duroc Jersey.—Moderately broad, very deep and full, carrying thickness well down and extending above line of back.

Chester White.—Broad, deep, and full, extending in a straight line with the side, and carrying size down to line of belly.

Victoria.—Broad, deep and full; not higher than the line of back and as wide on top as back.

Objections.

Poland China.—Narrow at the top or bottom, not so deep as the body, uneven width; shields on pigs under eight months of age, or showing too much shield at any age.

Berkshire.—Lacking in depth or width; thick beyond the line of sides and hams or extending above line of back; heavy shields on hogs under eighteen months of age.

Duroc Jersey.—Small, thin, shallow, extending above line of back; boars under one year old heavily shielded.

Chester White.—Narrow at top or bottom; not full nor same depth as body, extending above line of back; shields on boars too coarse and prominent.

CHEST.

Poland China.—Large, wide, deep, and full; even underline to the shoulder and sides, with no creases; giving plenty of room for heart and other organs, making a large girth, indicating much vitality. Brisket smooth, even, and broad; wide between the legs, and extending well forward, showing in front.

Berkshire.—Large, wide, deep, and roomy; full girth; breast bone curving well forward, extending back on level; not tucked up; broad between fore legs.

Duroc Jersey.—Large, very deep, filled full behind shoulders; breast bone extending well forward so as to be readily seen.

Chester White.—Large, deep, and roomy so as not to cramp vital organs; full in girth around the heart; the breast bone extending forward so as to show slightly in front of legs and let down so as to be even with line of belly, showing a width of not less than 7 inches between fore legs of a full-grown hog.

Victoria.—Large, wide, deep, and roomy, with large girth back of shoulders.

Objections.

Poland China.—Pinched appearance at the top or bottom, or tucked in back of the fore legs; showing too narrow between the legs; not depth enough back of the shoulder; brisket uneven, narrow, not prominent.

Berkshire.—Flat, narrow at top or bottom, small girth, lacking depth or fullness; breast bone crooked or tucked up.

Duroc Jersey.—Flat, shallow, or not extending well down between fore legs.

Chester White.—Narrow, pinched, heart girth less than flank girth, too far let down between fore legs, breast bone crooked or too short.

BACK AND LOIN.

Poland China.—Broad, straight, or slightly arched, carrying same width from shoulder to ham; surface even, smooth, free from lumps, creases, or projections; not too long but broad on top, indicating well-sprung ribs; should not be higher at hip than at shoulder and should fill out at junction with side, so that a straight-edge placed along at top of side will touch all the way from point of shoulder to point of ham; should be shorter than lower belly line.

Berkshire.—Broad and straight, carrying same width from shoulder to ham; surface even and smooth without creases or projections, and not too long.

Duroc Jersey.—Back medium in breadth, straight or slightly arching, carrying even width from shoulder to ham; surface even and smooth.

Chester White.—Back broad on top, straight or slightly arched, uniform width, smooth, free from lumps or rolls, shorter than lower belly line, same height and width at shoulders as at ham; loin wide and full.

Victoria.—Broad, straight, or slightly arched, carrying same width from shoulders to ham, level and full at loin, sometimes higher at hip than at shoulder.

Objections.

Poland China.—Narrow, creased back of shoulders, swayed or hollow, dropping below a straight line; humped or wrinkled; too long or sunfish shape; loin high, narrow, depressed, or humped up; surface lumpy, creased, ridgy, or uneven; width at side not so great as shoulder and ham.

Berkshire.—Narrow, swayed, or hollow, dropping below a straight line.

Duroc Jersey.—Narrow, creased behind shoulders, swayed or humpbacked.

Chester White.—Back narrow, creased back of shoulders, sunfish shape, humped, swayed, too long or lumpy rolls, uneven in width; loin narrow, depressed, or humped.

SIDES AND RIBS.

Poland China.—Sides full, firm, and deep, free from wrinkles, carrying size down to belly; even from ham to shoulder; ribs of good length, well sprung at top and bottom.

Berkshire.—Sides full, smooth, firm, and deep, carrying size down to belly; even from ham to shoulder; ribs long, strong, well sprung at top and bottom.

Duroc Jersey.—Sides very deep, medium in length, level between shoulders and hams and carrying out full down to line of belly; ribs long, strong, and sprung in proportion to width of shoulders and hams.

Chester White.—Sides full, smooth, deep, carrying size down to belly, even with line of ham and shoulder; ribs long, well sprung at top or bottom, giving the hog a square form.

Victoria.—Ribs well sprung at top, strong, and firm; sides deep, full, smooth, and firm, free from creases.

Objections.

Poland China.—Flat, thin, flabby, pinched, not as full at bottom as at top; drawn in at shoulder so as to produce a crease, or pinched and tucked up and in as it approaches the ham; uneven surface; ribs flat or too short.

Berkshire.—Flat, thin, flabby, not so full at bottom as at top; ribs weak; not well sprung at top or bottom.

Duroc Jersey.—Flabby, creased, shallow, and not carrying proper width from top to bottom.

Chester White.—Flat, thin, flabby, compressed at bottom, shrunken at shoulder and ham; uneven surface; ribs flat and too short.

BELLY AND FLANK.

Poland China.—Belly broad, straight, and full, indicating capacity and room, being about the same or on a level at the flank with the underline of the chest. Underline straight, or nearly so, and free from flabby appearance.

Berkshire.—Wide, full, and straight on bottom line.

Duroc Jersey.—Straight and full and carrying well out to line of sides; flank well down to lower line of sides.

Chester White.—Same width as back, full, making a straight line, and dropping as low at flank as at bottom of chest; line of lower edge running parallel with sides; flank full and even with body.

Victoria.—Wide, straight, and full; as low or slightly lower at flank than at chest; flank full and nearly even with the sides.

Objections.

Poland China.—Belly uneven and flabby or apparent looseness in the make-up; pinched up in the flank or flanked too high.

Berkshire.—Belly narrow and sagging; flank thin and tucked up.

Duroc Jersey.—Narrow, tucked up or drawn in, sagging, or flabby.

Chester White.—Belly narrow, pinched, sagging, or flabby; flank thin, tucked up, or drawn in.

HAMS AND RUMP.

Poland China.—Hams broad, full, deep, and long from rump to hock. Fully developed above and below, being wide at the point of the hip, carrying width well down to the lower part of the hams; fleshy, plump, rounding fullness perceptible everywhere; rump rounding and gradually sloping from the loin to the root of the tail; broad and well developed all along from loin and gradually rounding to the buttock; lower front part of ham should be full, and stifle well covered with flesh; even width of ham and rump with the back, loin, and body; even a greater width as to females, not objectionable.

Berkshire.—Hams broad, full, and long; the lower front part of ham should be full and stifle well covered with flesh, coming well down on hock; rump should have a rounding slope from loin to root of tail, same width as back, and filling out on each side and above the tail.

Duroc Jersey.—Broad, full, and well let down to the hock; buttock full and coming nearly down and filling full between hocks; rump should have a round slope from loin to root of tail, same width as back, and well filled out around tail.

Chester White.—Ham broad, full, wide, long, and deep, admitting of no swells; buttock full, neat, and clean, thus avoiding flabbiness; stifle well covered with flesh, nicely tapering toward the hock; rump should have a slightly rounding shape from loin to root of tail, same width as back, making an even line with sides.

Victoria.—Hams long, full, wide, nicely rounded, trim, and free from fat; buttocks large and full, reaching well down toward hocks; rump slightly sloped from end of loin to root of tail.

Objections.

Poland China.—Ham short, narrow, too round, or too slim; not filled out above or below, or unshapely for deep meat; not so wide as the body; back or loin too tapering or small; rump narrow or pointed, not plump or well filled, or too steep from loin to the tail.

Berkshire.—Ham narrow, short, thin, not projecting beyond and coming down on hock; cut up too high in crotch; rump flat, narrow, or too steep.

Duroc Jersey.—Ham narrow, short, thin, not projecting well down to hock; cut up too high in crotch; rump narrow, flat, or peaked at root of tail, or too steep.

Chester White.—Ham narrow, short, not filled out to stifle, too much cut up in crotch or twist, not coming down to hock; buttocks flabby, rump flat, narrow, too long, too steep, sharp or peaked at root of tail.

LEGS AND FEET.

Poland China.—Legs medium length, straight, set well apart and squarely under body, tapering, well muscled and wide above knee and hock; below hock and knee, round and tapering, capable of sustaining weight of animal in full flesh without breaking down; bone firm and of fine texture; pasterns short and nearly upright; feet firm, short, tough, and free from defects.

Berkshire.—Legs short, straight, and strong, set wide apart with hoofs erect and capable of holding good weight.

Duroc Jersey.—Medium size and length, straight, nicely tapered, wide apart, and well set under the body; pastern short and strong; feet short, firm, and tough.

Chester White.—Legs short, straight, set well apart and squarely under body; bone of good size; firm, well muscled, wide above knee and hock; below knee and hock round and tapering, enabling the animal to carry its weight with ease; pastern short and nearly upright; feet short, firm, tough, and free from defects.

Victoria.—Legs short, set well apart and firm, wide above knee and hock, tapering below; feet firm and standing well up on toes.

Objections.

Poland China.—Legs long, slim, coarse, crooked; muscles small above hock and knee; bone large, coarse, as large at foot as above knee; pasterns long, slim, crooked, or weak; the hocks turned in or out of straight line; legs too close together; hoofs long, slim, and weak; toes spreading or crooked or unable to bear up weight of animal without breaking down.

Berkshire.—Legs long, slim, coarse, crooked; muscles light, pastern long, slim, or flat; feet long or sprawling.

Duroc Jersey.—Legs extremely long or very short, slim, coarse, crooked; as large below knee and hock as above, set too close together; hocks turned in or out of straight line; feet, hoofs long, slim, and weak toes, spreading or crooked.

Chester White.—Legs too short, long, slim, crooked, too coarse, too close together; weak muscles above hock and knee; bone large and coarse, without taper; pastern long, crooked, slim, like a deer's; hoofs long, slim, weak; toes spreading, crooked, or turned up.

TAIL.

Poland China.—Tail of medium length and size, smooth, and tapering well and carried in a curl.

Berkshire.—Set well up, fine, tapering, and neatly curled.

Duroc Jersey.—Medium, large at base and nicely tapering and rather bushy at end.

Chester White.—Small, smooth, tapering, well set on, root slightly covered with flesh, carried in a curl.

Victoria.—Small, fine, and tapering, nicely curled.

Objections.

Poland China.—Coarse and long without a curl; or short, crooked, or stubby; or too small, fine, even, not tapering.

Berkshire.—Coarse and straight, too low.

Duroc Jersey.—Extremely heavy, too long, and ropy.

Chester White.—Coarse, long, clumsy, set too high or too low, hanging like a rope.

COAT.

Poland China.—Fine, straight, smooth, lying close to and covering the body well; not clipped; evenly distributed over the body.

Berkshire.—Fine, straight, smooth, lying close to and covering the body well; not clipped; evenly distributed over the body.

Duroc Jersey.—Moderately thick and fine, straight, smooth, and covering the body well.

Chester White.—Fine, straight, or wavy, evenly distributed, and covering the body well; nicely clipped coat no objection.

Victoria.—Fine and silky, evenly covering the body.

Objections.

Poland China.—Bristles, hair coarse, harsh, thin, wavy, or curly; swirls, standing up, ends of hair split and brown, not evenly distributed over all of the body except belly; clipped coat should be cut 1.5 points.

Berkshire.—Hair coarse, harsh, wavy or curly, not evenly distributed over body; swirls or clipped.

Duroc Jersey.—Too many bristles, hair coarse, harsh, and rough, wavy or curly; swirls or not evenly laid over the body.

Chester White.—Bristles, hair coarse, thin, standing up, not evenly distributed over the body, except the belly.

COLOR.

Poland China.—Black with six white points—tip of tail, four white feet, and white in face, on the nose or on the point of lower jaw—all to be perceptible without close examination; splashes of white on the jaw, legs, or flank, or a few spots of white on the body not objectionable.

Berkshire.—Black, with white on feet, face, tip of tail, and an occasional splash on arm.

Duroc Jersey.—Cherry red without other admixtures.

Chester White.—White (blue spots or black specks in skin shall not indicate impurity of blood).

Victoria.—White, with occasional dark spots on skin.

Objections.

Poland China.—Solid black, white mixed or sandy spots; speckled with white hairs over the body; mottled face of white and black; hair mixed, making a grizzly appearance.

Berkshire.—Solid black or black points, or white spots on body.

Duroc Jersey.—Very dark red or shading brown, very pale or light red, black spots over the body, black flecks on belly and legs not desired, but admissible.

Chester White.—Color any other than white.

SIZE.

Poland China.—Large for age; condition, vigor, and vitality to be considered. There should be a difference between breeding animals and those kept or fitted for the show of at least 25 per cent in size. In show condition, or when fat, a 2-year-old boar should not weigh less than 600 pounds, and a sow not less than 500 pounds; boar 1 year and over, 400 pounds; sow, 350 pounds; boar 18 months' old, 500 pounds; sow, 450 pounds; boars and sows 6 months' old, not less than 160 pounds; all hogs in just fair breeding condition, one-fourth less for size. The keeping and chance that a young hog has cuts quite a figure in his size and should be considered, other points being equal. Fine quality and size combined are the desirable points.

Berkshire.—Large for age; boar 2 years and over, not less than 450 pounds; sow, same age, 400 pounds; boar 18 months, 350 pounds; sow, same age, 325 pounds; boar 12 months, 300 pounds; sow, same age, 275 pounds; boar and sow 6 months, 150 pounds.

Duroc Jersey.—Large for age and condition; boars 2 years old and over should weigh 600 pounds; sow, same age and condition, 500 pounds; boars 18 months, 475 pounds; sow, 400 pounds; boars 12 months, 350 pounds; sow, 300 pounds; boar and sow pigs 6 months, 150 pounds. These figures are for animals in a fair show condition.

Chester White.—Large for age and condition; boars 2 years old and over, if in good flesh, should weigh not less than 500 pounds; sow, same age and condition, not less than 450 pounds; boars 18 months old, in good flesh, should weigh not less than 400 pounds; sows, 350 pounds; boars 12 months old, not less than 300 pounds; sows, 300 pounds; boars and sows 6 months old, not less than 150 pounds each; and other ages in proportion.

Victoria.—Boars 2 years old and over, when in good condition, should weigh not less than 500 pounds; sow, same age and condition, 450 pounds; boar 12 months old, not less than 300 pounds; sows in good flesh, 300 pounds; pigs 5 to 6 months old, 140 to 160 pounds.

Objections.

Poland China.—Overgrown, coarse, flabby, loose appearance; gangling, hard to fatten; too fine; undersize; short, stubby, inclined to chubby fatness; not a hardy, robust animal.

Berkshire.—Underweight, coarse, not in good form to fatten.

Duroc Jersey.—Rough and coarse and lacking in feeding qualities.

Chester White.—Overgrown, coarse, uncouth, hard to fatten.

ACTION AND STYLE.

Poland China.—Action vigorous, easy, and graceful; style attractive; high carriage; in males testicles should be prominent and of about the same size, yet not too large and pouchy.

Berkshire.—Action vigorous; style graceful and attractive.

Duroc Jersey.—Action vigorous and animated; style free and easy.

Chester White.—Action easy and graceful; style attractive; high carriage; in males testicles should be readily seen, same size and carriage.

Victoria.—Action easy and graceful, but quiet.

Objections.

Poland China.—Clumsy, slow, awkward movement; low carriage; waddling or twisting walk; a seemingly tired or lazy appearance; not standing erect and firm.

Berkshire.—Dull, sluggish, and clumsy.

Duroc Jersey.—Dull or stupid, awkward, and wabbling; in boars testicles not easily seen, nor of same size or carriage, too large, or only one showing.

Chester White.—Sluggish, awkward, low carriage, wabbling walk; in males testicles not easily seen, not of same size or carriage, or only one showing.

CONDITION.

Poland China.—Healthy, skin clear of scurf, scales, or sores; soft and mellow to the touch; flesh fine, evenly laid on and free from lumps and wrinkles; hair soft and lying close to body; good feeding qualities.

Berkshire.—Healthy, skin clear of scurf, scales, or sores; soft and mellow to the touch; flesh fine, evenly laid on and free from lumps; hair soft and lying close to body; good feeding qualities.

Duroc Jersey.—Healthy, skin free from any scurf, scales, sores, or mange; flesh evenly laid over the entire body and free from any lumps.

Chester White.—Healthy, skin clear and bright, free from scurf or sores; flesh fine and mellow to the touch, evenly laid on and free from lumps; good feeding qualities.

Victoria.—Healthy, skin clear and white or pink in color; free from scurf; flesh firm and easily laid on.

Objections.

Poland China.—Unhealthy, skin scaly, wrinkled, scabby, or harsh; flabbiness or lumpy flesh; too much fat for breeding; hair harsh, dry, and standing up from body; poor feeders; deafness, partial or total.

Berkshire.—Unhealthy, skin scaly, scabby, or harsh; flabbiness or lumpy flesh; too much fat for breeding; hair harsh, dry, and standing up from body; poor feeders; deafness, partial or total.

Duroc Jersey.—Unhealthy, scurfy, scaly, sores, mange; too fat for breeding purposes; hair harsh and standing up; poor feeders.

Chester White.—Unhealthy, skin scaly, scabby, or harsh; flesh lumpy or flabby; hair harsh, dry, and standing up from body; poor feeders; total deafness.

DISPOSITION.

Poland China.—Lively, easily handled, and seemingly kind and responsive to good treatment.

Berkshire.—Quiet, gentle, and easy to handle.

Duroc Jersey.—Very quiet and gentle; easily handled or driven.

Chester White.—Quiet, gentle, and easily handled, with ambition enough to look out for themselves if neglected.

Victoria.—Quiet and gentle.

Objections.

Poland China.—Cross, sluggish, restless, wild, or of a vicious turn.

Berkshire.—Cross, restless, vicious, and wild.

Duroc Jersey.—Wild, vicious, or stubborn.

Chester White.—Cross, restless, vicious, or wild; no ambition.

DISQUALIFICATIONS.

FORM.

Berkshire.—Very large and heavy or drooping ears; small, cramped chest-crease back of shoulders and over the back so as to cause a depression in back easily noticed; deformed or crooked legs; feet broken down, so that the animal walks on pastern joints.

Duroc Jersey.—Ears standing erect; small, cramped chest; crease back of shoulders and over back, so as to cause a depression in the back easily noticed; seriously deformed legs; badly broken-down feet.

Chester White.—Upright ears; small, cramped chest; crease around back of shoulders and over the back, causing depression easily noticed; feet broken down, causing the animal to walk on joints; deformed or badly crooked legs.

Victoria.—Crooked jaws or deformed face; crooked or deformed legs; large, coarse, drooping ears.

SIZE.

Berkshire.—Overgrown, gangling, narrow, contracted, or not two-thirds large enough for age.

Duroc Jersey.—Very small or not two-thirds large enough, as given by the standard.

Chester White.—Chuffy, or not two-thirds large enough for age.

CONDITION.

Berkshire.—Barrenness, deformed, seriously diseased, total blindness from any cause.

Chester White.—Squabby fat, deformed, seriously diseased, barrenness, total blindness.

Victoria.—Excessive fatness, barrenness, deformity in any part of the body.

SCORE.

Berkshire.—Less than 60 points.

Duroc Jersey.—Less than 50 points.

Chester White.—Less than 60 points.

PEDIGREE.

Berkshire.—Not eligible to record.

Duroc Jersey.—Not eligible to record.

Chester White.—Not eligible to record.

Victoria.—Not eligible to record.

COLOR.

Chester White.—Black or sandy spots in hair.

Victoria.—Other than white or creamy white, with occasional dark spots in skin.

Differences between breeds as units.—The foregoing remarks apply to the individual characteristics of the animals of the different breeds, regarding them simply from the meat-producing standpoint. Considering each breed as a unit, it will be noticed that there are varying degrees of adaptability to environment. One breed succeeds well in a certain locality while another does not; some breeds graze and "rustle" better than others. In the Northern States color is only an incidental item except in the case of purebred stock, where a color standard is always maintained; but in the Southern States white hogs are not desired, it being claimed that they are too susceptible to the heat of the sun.

SELECTION OF A BREED.

The principal point to be observed in the selection of a breed is, therefore, its adaptability to the climate and environment of the locality in which the beginner desires to operate. The best plan will be, obviously, to make a selection from the breeds already established in the neighborhood, consulting successful breeders freely. If, as sometimes happens, a man finds himself compelled by circumstances to become a pioneer in hog raising, a selection should be made from breeds already successful in sections of the country similar to his own. Broadly speaking, there is no "best breed." All have their strong points. Most of them will flourish in almost every part of the country; but consulting his own personal preferences and the locality in which he lives the farmer will find that, for his own use, there is probably a breed that he may consider the best. When a breed is once chosen it should be reasonably adhered to, and promiscuous crossing with other breeds avoided.

THE BREEDER.

After the locality and breed have been decided upon, and the various details that are incident to a beginning settled, it may be well for the beginner to examine into his own qualifications. To make stock raising of any kind a success a man must be, first of all, a lover of animals, taking a delight in their growth and development and quick to understand their needs. He must enjoy the labor of caring for them and must be willing to give that labor without grudging and often without stint. He should be cleanly and neat in habits, and then his barnyard will be likewise. A knowledge of some of the laws of sanitation and veterinary science will be a great help, and an acquaintance with the principles of selection and breeding of stock is, of course, a necessity. The apparent ease with which many men succeed with live stock is due, in large measure, to the possession of this intimate knowledge of the habits and requirements of their animals. They do not pamper their stock, but they never neglect it. The personality of the breeder, including good health, natural intelligence, etc., has more to do with success or failure than any other factor after a suitable location, and will do wonders toward overcoming a harsh climate and an unproductive soil.

THE FOUNDATION HERD.

The first selection of breeding stock is of prime importance. The effects of mismating are always difficult to breed out of a herd, and the effect on a beginner is such that a mistake may completely discourage him. It is good economy to make haste slowly at this time. The start should be made with a few animals; five sows will make a large enough herd for the first year. They should be good individuals, and it will even be much better to buy one high-class sow than five poor ones. This will be real economy and the development of the herd will prove its value. It will be well if a beginner can obtain the assistance of an old and successful breeder in making a start.

SELECTING THE SOWS.

The expression "the male is half the herd" is repeatedly quoted. So far as our knowledge of heredity has developed, other conditions being equal, there is uniform prepotency in both sexes; the influence of the two parents on the offspring is theoretically equal. Therefore, if the boar is half the herd, the sows certainly make up the other half, and their selection is a highly important matter. They may be purchased, already bred, some time before the boar, and quite an item of expense will thus be saved. Then by the time the sows have been watched and studied for a season and have each raised a litter of pigs, the owner will be much better prepared to select a suitable male, and he can then get one to use on both dams and offspring.

The sows selected should be nearly the same age, which should be about twelve months, and all should be safe in pig, preferably to the same boar. Their individual characteristics should, perhaps, be first looked to. While hogs do not show the strong differences of sex that we look for in a cow or a mare, these always constitute a marked feature of a good brood sow. The smoother forehead and lighter, finer neck are points of distinction from the signs of masculinity in a boar. The forehead should be broad between the eyes, the throat clean and trim, the neck moderately thin, and the shoulders smooth and deep; the back should be fairly wide and straight, and ample room for the vital organs should be provided by a good width and depth of chest, well-sprung ribs, and straight, deep sides—a deep, capacious body from end to end. Depth of chest and abdomen are specially important in a brood sow. Pinched chests and waists must be avoided. It is generally advised that sows with much length of body should be selected for breeding purposes, length of body being regarded as an indication of fecundity. It will certainly do no harm to select sows that are especially long, but care should be taken that quality go with the increase in length. The loose-jointed, long-coupled, slow-maturing, and slow-fattening type should not be allowed to get a foothold in the herd. The influence of length of body on a sow's fecundity is by no means positively known. Many very short-bodied sows have proved to be wonderfully prolific breeders. The surest means by which to select prolific sows is to keep an accurate record of the herd and cull all sows that do not yield a certain percentage annually. Each sow should have at least twelve well-developed teats, thus providing for the proper nourishment of large litters.

The important qualifications of the market hog should be looked for; viz, smoothly covered shoulders, a wide, straight, deeply fleshed back, well-sprung ribs, straight, deep sides, broad rumps, and deep, well-rounded hams. A broad, well-developed pelvic cavity will generally insure a sow easy in parturition. The body should stand on moderately short, straight legs, with a moderate amount of bone. All hogs, particularly breeding animals, should stand well up on the toes. There is a tendency, more marked in some breeds than in others, for the pasterns to break down, so that the animal walks on the pastern bone instead of on the toes. This is particularly the case of the hind pasterns and is oftener noticed in boars than in sows. It is a weakness that seriously impairs the usefulness of the animal.

Brood sows should, of course, show quality, but this should not become overrefined and delicate. Extremes of refinement usually lead to delicacy of constitution and often accompany sterility.

As a last but very important point, these first sows should be uniform in type. Uniformity of type goes far beneath the surface. It includes every part of the internal organization. The reproductive system, the digestive system, the circulatory system, and even the nervous system influence uniformity. The breeder may often be disappointed in his results from sows that he thought were of a uniform type. His pigs are a heterogeneous lot, unpleasing to the eye, unsatisfactory in the feed lot, and profitless to the pocket. In such a case a lack of uniformity in the powers of heredity may no doubt be assigned as the cause of these unfortunate results. It must be borne in mind that it is comparatively easy to select sows that are uniform in quality, constitution, and conformation. This may be done by any skillful judge of hogs. But our only basis for the selection of animals uniform in reproductive powers and heredity of type is the breeding record of their sires and dams and the standard of the herds from which they come. For this reason it is readily apparent why it is an advantage for the beginner to select his sows from one well-established herd. Whether the sows will be uniform in breeding powers can only be determined definitely by testing them in the herd, but to select them from the same herd or from herds of similar breeding will be a reasonable guaranty of good results. When a sow has shown herself to be a prolific breeder she should be retained as long as her reproductive powers are maintained.

Uniformity in a herd is the surest index to the worth of the stock and the skill of the breeder, and its advantages are obvious. A uniform lot of pigs will feed better, look better when fattened, and command a higher price on the market than a mixed lot. With a bunch of sows closely conforming to the same standard, whose reproductive powers are similar, uniform pigs may be expected.

The importance of the male in the herd should not be asserted at the expense of the females, yet the importance of a male of marked excellence must not be minimized. The boar represents 50 per cent of the reproductive power concentrated in one animal; the sows represent an equal amount of reproductive force, divided up among ten or twenty or fifty individuals. If, then, these females do not, in their conformation and fecundity, conform strictly to the same type, they are merely convenient machines for the birth and rearing of young—not what they might be, an influential force in furthering the plans of the breeder and raising the standard of the herd. It is not proposed to discuss at length in these pages the operation of the forces of prepotency as varying factors in breeding operations. The relative influence of one parent over another, the swamping of a weakly organized female influence by a strongly prepotent male factor, or vice versa, are interesting and important, but belong to the special study of heredity.

SELECTING THE BOAR.

If there is a tendency at times to exalt unduly the influence of the boar and neglect that of the sows, the beginner should not permit himself to reverse things and entirely neglect the boar. It was, indeed, the feeling that any male could be used so long as he had sufficient strength for service that brought about arguments in favor of the value of the boar. A breeder can not afford to neglect the animals of either sex. The male has, perhaps, the greater influence on the herd, for the simple reason that every pig in the herd is sired by him, whereas they have not all the same dam. To achieve the best results, a breeder should never allow the standard of his sows to be lowered, and should always couple them with a boar of a little better grade. One thing must not be forgotten, and it indicates the chief difference between the influence of the two sexes in the herd. A superior boar may be used on a herd of inferior sows with good results, but the use of an inferior boar on sows of high quality will have a disastrous outcome. The one method raises the standard of the herd; the other inevitably lowers it.

A boar with the male characteristics strongly developed should be selected, preferably as a yearling or else as a pig that had been purchased at the same time as the sows and allowed to come to maturity before using. He should have a strongly masculine head and a well-crested neck. His shoulders should be developed according to age; but strong shoulder development in pigs under a year or eighteen months is objectionable. The same indications of a good pork-producing carcass that the sows required should be seen in the boar—a broad, straight, deeply fleshed back, much depth and length of side, and well-developed hind quarters. The boar should be selected to correct any defects that may be common to the sows; for example, if the sows are rather coarse in bone and loosely built, the boar should have high quality—fine bone, skin, and hair. If the sows tend toward overrefinement and delicacy, the boar should be rather rangey and strong-boned. There is a common belief that the male parent influences principally the extremities and general appearance of the offspring, while the vital organs (the heart, lungs, and viscera) resemble those of the female parent. This theory is strongly questioned by some modern authorities on heredity; but so long as our knowledge of the subject is so limited and this particular phase is in dispute, it can do no harm to select breeding animals according to the old ideas. The visible organs of the reproductive system should be well developed and clearly defined. A boar should not be bought with small, indefinitely placed testicles. Avoid particularly a boar with only one testicle visible.

The boar should stand up on his toes. There should not be the slightest indication of weakness in the pasterns of a young one; in a mature boar (2 or 3 years of age) that has seen hard service it may be expected that he will be a little down on his pasterns, but a 6 or 8 months old pig that does not carry himself on upright pasterns is not a safe animal to select for a herd boar; the hind pastern will be in much danger of breaking down with a little age and service. Look carefully to the set of the hind legs. The back should be carefully set, straight, and closely coupled to hindquarters. A crooked or long-coupled back is as great a drawback as a weak pastern.

FEED AND MANAGEMENT.

The details of selection, feed, and management of live stock are intricately interwoven and interdependent. A man may be an excellent judge of stock, able to select those animals for his herd whose use will give the best results in breeding; but if his system of feeding and management is not such that the animals will thrive and yield a good increase, good selecting is rendered ineffective. On the other hand, the herd may be carefully fed and skillfully managed, the feed may be the best and properly combined, the shelter warm and dry, and the water supply pure; but if the herd is poorly selected the owner is practically throwing away the feed he gives them.

THE SOWS.

Hogs require attention, regardless of condition, age, or sex, but the management of the brood sows is the surest test of the breeder's skill. If sows are carelessly fed during pregnancy, trouble of some kind is sure to ensue at farrowing; if overfed after farrowing, losses may occur among the pigs from scours and thumps. At no time is the development of the pigs so easily influenced as while they are dependent on the sow's milk—the first month of life. Excepting the ravages of epidemics, perhaps the greatest death losses in the herd occur during this time, including farrowing. The accidents during farrowing, an attack of scours due to the milk of the dam, or a chill while following the sow in pasture on a wet day, may stop growth temporarily, leaving a permanently stunted pig, or may result fatally. On the other hand, the results of good management during pregnancy are as marked as the unfortunate consequences of careless methods.

MANAGEMENT DURING PREGNANCY.

It is assumed that bred sows are purchased as the foundation stock. If these sows are not all from the same herd, they should not be placed together until they are all known to be free from vermin and contagious disease. They must be washed or dipped and quarantined from each other at least thirty days. If they come from the same herd, quarantine may not be necessary.

It is always well for a purchaser to ascertain from the seller the details of management and feeding to which the animals were accustomed before changing owners. This system of feeding should be conformed to; or, if this is not possible, the old ration should be gradually replaced by the more convenient one, the time of transition being from ten days to two weeks. For the first few days newcomers should be fed lightly.

During pregnancy two facts must be borne in mind. The first is that the sow is doing double duty. Not only is she keeping up her own bodily functions, but the development of the fetal litter is a constantly increasing drain on her system. Although feeding at this time will not need to be so heavy as after the pigs are farrowed, it should be liberal. The sow's condition should be "good"—neither too fat nor too lean. An error which would allow the sow to become fat would perhaps be least productive of serious consequences. It is hardly too much to say that the mistakes in feeding breeding animals are more frequently those that keep such stock in a thin, half-starved condition, under the idea that the reproductive organs are so peculiarly liable to become transformed into masses of fat that the least appearance of fat on the animal's back and ribs will be the first step in bringing about such unfortunate circumstances. The use of the reproductive organs in either sex creates demands of an unusual nature on the animal organism, and these demands must be met in the same manner as those of a different character—such as growth, work, etc.; and that is by providing liberal supplies of the proper kinds of feed. It is beyond reason that a sow can give birth to a strong litter of pigs after having gone through a four months' fast. The importance of ample feeding of pregnant females, in the case of sheep, has been shown recently by Mumford[a] in Missouri. He found that during the first six to nine weeks of life those lambs having the heaviest birth weight made the greatest gains; the records of the gains of the lambs after weaning were not tabulated. As the development of the fetus is intimately associated with the nutrition of the dam, it is urged that "we can profitably pay more attention to the development of the unborn lamb." Whether a similar fact may be true in the case of hogs is yet to be shown. It may not be unwise to assume that it may be so. Bad results undoubtedly may be brought about by overfeeding, especially as sows are naturally indolent and loath to exercise; but a counteracting influence will be found in ample exercise that may be provided by a large pasture, or even by driving slowly a mile or two each day. The necessity of exercise must not under any circumstances be overlooked.

It must be remembered, in the second place, that the main demands upon the sow are those for the building of new tissue. Hence the kind of feed is important. What are known as the nitrogenous, or protein-bearing, feeds are needed at this time. These are bran, oil meal, pease, beans, oats, and barley, and, to a moderate extent, wheat. The forage plants that are especially suitable to pregnant brood sows are the clovers and their relatives—alfalfa, peas, beans, vetches, etc. The ordinary pasture grasses are also of much value. Feed should be given in such form that the system of the sow will be at its best. All breeders lay special emphasis on the condition of the bowels during pregnancy, and particularly at farrowing, the special danger to be avoided being constipation. To this end, the greater part, if not all, of the grain ration is given as slop; and, toward the close of the period of gestation, oil meal, or a small amount of flaxseed meal, is introduced into the ration.

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[a] Bul. No. 53, Missouri Expt. Sta.

Corn should not be fed in large amounts to breeding stock. If possible, it should not be fed at all to any but fattening animals. In the corn belt many farmers are often so situated that they have no other grain feed at hand. If corn must make up the greater part of the ration of the brood sow, the injurious effects may be counteracted in a measure by compelling the sows to exercise. Various schemes may be necessary to bring about this result, such as having the house and feeding floor or the feeding floor and watering place at opposite ends of the hog lot; so that a good walk is a necessity several times each day. If the lot is located on a hillside, the walk is made a climb. Some men scatter grain among straw and corn fodder with this idea of exercise in mind, and others resort to the whip and drive the sows gently for a mile or two each day.

During the winter more care will be needed to keep the sow in good health on account of the absence of pasture. Not only does the hog's system crave green feed, but more or less bulk is demanded. This is especially needed when a considerable amount of confinement is necessary. To offset the lack of green feed, nothing surpasses roots. These may be sliced or pulped and mixed with the grain or may be given whole, as a noon feed. Some care must be used in feeding roots, as they are laxative in effect, and if fed in excessive amounts, may bring about profuse action of the bowels. Some Eastern farmers recommend the use of silage. If neither is available, clover or alfalfa hay, sheaf oats, or corn fodder may supply the bulky requirement of the ration with good results. Charcoal, ashes, and salt should be accessible at all times. These act as a vermifuge and preventive of disease and meet the hog's craving for mineral matter in the feed. The constant use of such a preparation with a varied ration, will, in large measure, prevent sows from eating their pigs at farrowing time. During the entire period care should be taken to keep the system well toned. The condition of the bowels is highly important; for pregnant and "down" pigging sows are subject to constipation, which may have serious results during farrowing. The sow should become accustomed to being handled, and should look upon her attendant as a friend.

All the brood sows may run together up to within two weeks of farrowing time; then it is well to separate them, placing each sow by herself in a yard with a small house, such as has been described, which should be dry, airy, and clean. A great deal of exercise will not now be necessary. The feed should be reduced somewhat, and, if there is any tendency to constipation, a slight change of feed may be necessary. If individual houses are not available sows can not be separated until near farrowing time.

The farrowing pen should be provided with fenders around at least three sides about 6 or 8 inches from the floor and 6 or 8 inches from the wall. These should be strong enough to support the weight of the sow should she lie on them. They will, in a large measure, protect the pigs from being lain upon during the first few days of their lives. This will go far to prevent a very fruitful cause of loss among young pigs. The little fellows will soon learn to creep under these fenders when the sow lies down.

Many breeders now use a specially arranged farrowing pen for sows, the object being to allow the sow room enough to farrow with reasonable comfort, but not enough to turn around. The safety of the pigs under such circumstances is said to be much greater than when the sow is given all the space she cares to take. Provision is made for the safety of the pigs by raising the walls of the pen 6 or 8 inches from the floor. Such a pen may be readily arranged by placing the sow at one end of her pen and nailing boards across so that she can not turn, leaving space for the pigs to slip under the barrier. A number of patented farrowing pens are on the market.

OPINIONS OF BREEDERS.

In the preparation of this bulletin, requests for methods and experience in hog raising were sent to successful breeders in different parts of the country. These men were practically all breeders of purebred hogs, and it may be objected at first thought that methods used by them are too expensive to warrant their application to the production of hogs for the market. To a certain extent this is true. A man with 50 or 100 sows will hardly find it possible or economical to keep an exact breeding record of each one; he can, however, keep himself acquainted with the breeding record of the herd by grouping those sows that are due to farrow at or near the same time and those that farrow or raise litters of certain numbers. Constitution, uniformity, disposition, etc., can all be regulated in a market herd in the same manner. In feed and management, however, the methods of the successful breeder of purebred animals may be taken as models. Because a pig is a grade is no reason why he should be compelled to live in filth, eat poor feed, and sleep where fortune compels him, often without a semblance of shelter. There is, of course, a possibility that attention may be so assiduous that the animals suffer; but, where one hog is killed by care and kindness, thousands die from disease which gets its foothold on account of insanitary surroundings and improper feed. With this idea in view, the opinions of breeders on various phases of the industry are given. These opinions are the personal experiences of men in the business and represent various ideas and theories. It is therefore obvious that the Bureau of Animal Industry is not responsible for any statements made therein.

The following replies were among those given in response to the question, "What system of feed and management do you pursue to prepare sows for farrowing?"

George Aitken, Woodstock, Vt.—In the summer they are put into a separate inclosure with a temporary shelter; in the winter they are in separate pens and fed laxative feed—principally mangels.

H. O. Mathews, Concord, N. H.—I keep my brood sows in a moderate condition—not too fat; feed on hotel waste combined with mixed feed, sugar beets, and clover hay; give them exercise in yards all winter, and warm, dry beds, making sure that they have pure air.

E. W. Davis, Torringford, Conn.—The one thing needful is to have the bowels loose. I have had excellent success in feeding mangolds through the winter. These, with wheat bran, will bring the best of hogs. Sows should also have exercise; then, with the above feed, there is no danger of them destroying their pigs.

Theron E. Platt, Newtown, Conn.—For feed we use skim milk and wheat feed, with some green feed, such as roots and cabbage for winter and in summer grass or clover.

Richard H. Stone, Trumansburg, N. Y.—The sows are well cared for and well fed; feed warm bean soup with wheat bran or middlings, with some bone meal and tankage. To 150 head we feed about 400 gallons of soup per day.

Edward van Alstyne, Kinderhook, N. Y.—I keep my sows in good condition, not fat nor very thin, giving them laxative feed, and pasture if possible. In the winter they have silage or roots with wheat bran and plenty of exercise in the open air, on the ground if possible.

F. H. Gates & Sons, Chittenango, N. Y.—We feed middlings mixed with hominy meal or clear middlings in whey or skim milk; this will keep their bowels loose and the animals in good growing condition (not fat). We give a dry bed of straw, just a thin layer on the floor, and arranged so that the little pigs can not get into the gutter.

George L. Gillingham, Moorestown, N. J.—They are allowed the free run of the pasture the entire year, with warm, dry houses to sleep in, not over three or four being put together, to avoid crowding. The feed in summer is wheat middlings, apples, or other refuse fruit, and pasture; in the winter they have rye to graze when the snow is off, with roots, clover hay, middlings, etc., but very little corn.

William M. Dickson, Woodside, Del.—We give as large a lot to range as possible. The feed in winter is silage, turnips, and slop with bran and meal in it. This is varied with a little corn on the ear; never cob meal.

J. S. Burns, Clinton, Pa.—By breeding time in the fall the sows are usually rather thin in flesh, especially if they have raised a fall litter. For two or three weeks before we mate them we feed some corn in connection with clover pasture; but if there is no pasture we use corn, milk, and mill feed, making a ration with a ratio of about 1:7 or 1:8, depending on the sow's condition. If she is in good flesh we do not begin so soon and the ration is made narrower. The object is to have the sow vigorous at breeding time. We continue the feeding in this way until they are in such flesh as most people would think fat enough for pork, then narrow the ration to about 1:4 or 1:5, dropping out the corn about four weeks before farrowing; if in midwinter, furnishing warm quarters instead of heat-producing feed, avoiding everything that would produce a feverish system. We feed turnips, beets, parsnips, etc., for succulence. We always allow exercise, giving the range of a pasture lot. The feeding place is some distance from the sleeping quarters.

N. S. Burrier, New Midway, Md.—After a sow weans her pigs I breed her at once, as she is generally thin in flesh. I feed her all she will eat of such feeds as bran and middlings, pasture, etc., and any feed, except corn. Feed only two ears of corn twice a day to each sow, but try to put on flesh with other feeds, giving the sow plenty of range. An apple orchard is a splendid place for this; if a spring branch runs through it, so much the better. By this method of feeding the sow is in good flesh by farrowing time and the pigs are large and strong; whereas, if the sow is shut up in a close pen and fed on corn, the pigs will be small and weak. Some people always say that my sows are too fat at farrowing time; but I find that theirs are too poor; one can hardly ever get a sow too fat on the right kind of feed and plenty of range.

John F. Lewis, Lynnwood, Va.—I generally feed shorts and bran made into a mash once a day and a feed of corn once, if the weather is very cold; if not, I feed shorts, bran, and barley, equally divided as to bulk.

Thomas S. White, Lexington, Va.—I have eight farrowing pens of two rooms each. I watch my gestation table and put the sows (one in each two-room house) a few days before farrowing, each sow then having a sleeping room and dining room; the former can be made perfectly close, the latter is open overhead. I feed bran mashes with a little corn for a week before farrowing.

J. C. Graves, Barboursville, Va.—I allow the pregnant sow plenty of range for exercise and feed mainly on bran, mill feed, and oats in winter, with some corn. In grazing time corn is all that is needed to supplement pasture.

Charles A. Kuhlmann, Hamilton, Va.—When nearing farrowing time I still allow my sows a grass range, if possible, or a lot in which to exercise themselves. Only a few are allowed to run together. I also furnish them with a good dry house, into which they can go at their own free will. I slacken the feeding until no corn at all is fed, and feed a mixture by weight of bran 3 parts, shorts or middlings 3 parts, corn meal 3 parts, old-process linseed meal 1 part, all in the form of slop.

W. K. Pickens, Livingston, Ala.—I feed wheat shorts made into slop and give the sow plenty of exercise, pure water, a warm sleeping place, and keep her free from all excitement.

W. E. Davis & Bro., Sherman, Tex.—When the sow is bred we put her on a pasture of some sort—oats, wheat, or alfalfa, as the case may be—and feed her on dry corn at night and soaked corn in the morning. We try to keep her gaining flesh all the time from breeding time to farrowing.

H. E. Singleton, McKinney, Tex.—From the weaning of one litter to the next farrowing sows have the run of a pasture and are fed bran and corn, the amount to be determined by the quality of the pasture.

Clifton Chisholm. Roswell, N. Mex.—My sows during the summer, when there is no green alfalfa, get nothing but alfalfa hay fed in racks for four months before farrowing. Out of 500 sows which farrowed this summer I had to assist only one.[a]

Mark Butterton, Miller, Okla.—My system of managing the sows before farrowing is to give them plenty of range on green pasture, with plenty of oats and a little corn. This year (1902) I have fed ground wheat with the best of results. In all cases I am careful not to let the sows get too fat.

A. D. Outher, Homestead, Okla.—My sows are given lots of range and an abundance of green wheat, alfalfa, cowpeas, and rape, besides oats, barley, wheat, corn, and shorts. They have exercise, sunlight, and roomy pens.

H. P. Wilson, Gadsden, Tenn.—For spring farrow I usually breed in November or December and give the sows the run of the fields and woods, with winter oats, rye, and rape for green pasturage, until growth stops from the cold, then I give bran and middlings mixed into a fairly thin slop twice a day with a little shelled corn, giving the corn after the slop. In midwinter I give the sows such hay as I have—clover, millet, cut corn, pea vine, or sorghum. I usually warm water for them in very cold weather. They have comfortable small houses to sleep in, two or three sows being in each house until near the farrowing period, when I give each sow a separate house. I feed all the salt and ashes they want and occasionally give them a round of prepared stock food. Keep lice from them by coal oil and grease or some of the disinfectant dips, which are also used freely in and around the sleeping quarters.

Karl B. Clough, North Amherst, Ohio.—During the warm months the sow has a large range on clover and blue grass with plenty of good water and shade. Should this not give enough food to keep her putting on flesh, a thin slop of middlings twice a day is added. As she becomes heavier with pig the middlings are increased, with the end in view that the sow will be in good condition at time of farrowing. In the cold months she is fed cowpeas, soja beans, or clover hay that has been baled. To this is added a slop of middlings or barley and a little corn meal. During early spring winter rye is pastured and takes the place of hay. We aim to keep the sow increasing in weight from the time of service until she farrows. Wood ashes, salt, and sulphur should be before them at all times. A little bone meal in the slop is very good.

Aaron Jones, jr., South Bend, Ind.—We give our sows as much outdoor exercise as possible; in fact, we never aim to have hogs in inclosed pens at any time. We think hogs grow faster and are more healthy if kept on pasture, and never on the same pasture and feed lots to exceed two years. Sows get little corn; good rich slop made from bran, middlings, finely ground rye, and ground wheat constitute their feed; blue grass and rape, their pasture. We aim to keep them tame and gentle, so that they can be handled at all times, and when farrowing time comes we have no difficulty with our sows; but should any of them have any trouble or fail to raise a good, large, thrifty litter we immediately discontinue her use as one of our brood sows and put her at once in the feed lot for market.

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[a] It is interesting to note that during December, 1902, Mr. Chisholm shipped to South St. Joseph, Mo., a train of nine loads of high-grade Poland China hogs that had been fattened on alfalfa and Kafir corn. Three loads, averaging 272 pounds, topped the market at $6.47½, selling considerably higher than the tops of the Kansas City and South Omaha markets for the same day. The remaining six loads averaged 223 pounds and sold at $6.37½. The train was run through from Roswell, N. Mex., to South St. Joseph, in forty hours without loss. It was the first shipment ever made from New Mexico to that market.

T. B. Pearson, Thorntown, Ind.—I desire a diversity of feed, consisting of shorts, oil meal, ground oats, with plenty of grass or forage—such feeds as produce bone and muscle—avoiding corn for brood sows very much, as it produces fat, and fat is not desired in brood sows. In mating, I turn the sow to the boar and allow only one service, then remove the sow and keep her isolated from other hogs until she passes over the heat period, which will not usually last over two days after service.

Davis Bros., Dyer, Ind.—We give them a good pasture or lot that they may get plenty of range, and feed good wheat middlings made into slop, with little or no corn near farrowing time.

Thomas Bennett, Rossville, Ill.—I usually feed some corn and oats before farrowing; the sows run in blue-grass pasture all winter, and I try to make them walk a mile for breakfast, which makes 2 miles every morning. I feed sparingly. Fat brood sows are a curse to anyone.

A. G. Woodbury, Danville, Ill.—Give sows exercise. Keep in fair flesh. Not over one-third of the feed is corn, the balance being oats, shorts, bran, and roots, with clover hay or early cut corn fodder in the spring for spring farrow; for fall farrow keep on grass.

A. J. Lovejoy & Son, Roscoe, Ill.—We feed wheat middlings, ground oats, and pasture in summer; in winter, the same feed, except that we use sugar beets or sorghum for a succulent feed to take the place of pasture. We give plenty of exercise, and separate the sows a week before the time of farrowing.

J. D. Orn, Mount Pleasant, Iowa.—After breeding, the feed consists of corn and oats in equal parts, with plenty of range, and clover hay when they need it. About seven days before farrowing I give them their place for farrowing and a loosening feed.

C. S. Barclay, West Liberty, Iowa.—I give them plenty of exercise on pasture and feed corn lightly, giving a light feed made of wheat shorts or middlings mixed with oats into a thin slop.

O. S. West, Paullina, Iowa.—I feed bran, shorts, and oat siftings, a product of the oatmeal mills. Corn is of secondary importance for breeding stock. I also see that their bowels are in good condition.

W. L. Niles & Son, Ames, Iowa.—Breeding animals are kept separate from the herd and fed a mixed ration. The aim is to supply them with muscle-forming feed and guard against excessive fatness. Some little time before farrowing each sow is given a pen by herself.

W. A. Jones, Van Meter, Iowa.—From breeding until farrowing time I feed 2 parts oats, 1 part wheat (dry), for the morning feed; equal parts by weight of gluten feed, germ-oil meal, shorts, and bran made into a warm slop, for the noon feed, and corn on the cob for the evening feed. I give plenty of good pure water, preferring it warm in cold weather, and give access to salt, wood ashes, and charcoal. The sows should have plenty of exercise, and not too many should be put together. They should have a comfortable sleeping place and should not be disturbed. The sows should be put into the farrowing pens a week before farrowing and fed light feed, but very little if any corn. Use the grass pasture whenever you can.

William D. McTavish, Coggon, Iowa.—My brood sows are fed twice daily. The morning feed consists of one-half wheat middlings and one-half ground oats, with a little oil meal added and thoroughly mixed; for drink, pure water. The evening meal is about five ears of corn to each sow, and pure water. Clover hay is fed every morning.

William B. Lambing, West Liberty, Iowa.—Three weeks before farrowing I feed oats chop once a day, corn once a day, and 1 pint of old-process oil meal once a day.

N. M. Shaffer, Cascade, Iowa.—Sows should have a slop made of mill feed, either bran, shorts, or ground oats, with some oil meal and a little ear corn. I think much of a good pasture. In the first place, a man should not keep too many hogs in one place, and small shoats should not be kept with a lot of old hogs, as they are apt to get crippled or smothered. In breeding hogs a man can not have too many lots, so as to change them often. He should clean the lots often. It is better to plow them and sow some grain; it makes good pasture. I have not lost a sow in farrowing in over ten years.

F. F. Failor, Newton, Iowa.—My sows have a blue-grass pasture of 40 acres in the winter and about 160 acres in the summer, and are fed a mixed ration of ground corn (including cob), with whole oats.

M. H. Donelson, Ogden, Iowa.—This time of the year (spring) the feed is one-third corn, one-third oats, and one-third shorts all ground, mixed, and fed as a rather thick slop. We grind the oats and corn with a seven-horse power gasoline engine, and buy the wheat products. Feed some corn at night when the weather is cold.

Thomas Teal & Son, Utica, Iowa.—We feed very little corn at any time to our brood sows while carrying their young. We make it a point to have them gaining in flesh at the time of breeding, and feed on oats, wheat, rye, and a small amount of ground corn.

R. J. Johnston, Humboldt, Iowa.—Oats and bran. I do not believe in feeding breeding stock much corn; wheat is far better. Corn is all right to finish with.

L. L. Young, Oakland, Nebr.—All my hogs are grown mainly on tame pastures and fed but little grain. For brood sows I select only the best developed, of a feminine type, and strong constitution. From breeding time to farrowing they are fed about equal parts of oats, wheat, and shelled corn, night and morning, and are fed sorghum cane or clover hay at noon; this causes them to take exercise. They are also fed a mixture of salt, ashes, air-slaked lime, and soft coal. Occasionally I give them a little lime in their drinking water, to supply bone-making material for the fetus. Sows are allowed to take exercise up to within two days of farrowing.

C. H. Searle, Edgar, Nebr.—We feed the same as the stock hogs until about two weeks before farrowing, when we put them in a good, warm house and feed slops made of one-third bran and two-thirds shorts, and feed beets twice a week, but no patent stock food.

E. F. Jackson, Malcolm, Nebr.—We feed sparingly of grain, allowing them a run of grass, with plenty of fresh water, shade, and comfortable sleeping quarters. We raise purebred pigs for the trade and want March and April farrow. Our aim is to have the sows in healthy, vigorous condition at breeding time. When the sows are safe in pig, they are divided into small lots of from three to six each. The feed is increased a little as the weather becomes colder, but they are not allowed to get fat and sluggish. We often let them out together in a large field in daytime and put them back in their separate quarters at night. They enjoy the run of the field, hunting about for something they do not have in the lot. Our hogs are fed only at morning and night, and we have come to think it more profitable to use the feeds that can be grown on the farm. The corn is fed shelled to the brood sows in farrow, scattered thinly along the ground, compelling them to eat slowly. We grind corn, oats, and wheat together in equal parts, and this, with the milk we get and the grass, makes a capital feed for the brood sow and suckling pigs.

S. McKelvie & Son, Fairfield, Nebr.—It is difficult to say here, but sows should have room to exercise at will and should not be too fat at breeding time. After breeding, large numbers should not be kept together, and they should not be fed too liberally on corn or other concentrated feed. It is well if they can have the run of a pasture. Bran and alfalfa are good things to balance their ration.

A. T. Shattuck & Son, Prosser, Nebr.—We feed little corn; all the other grains are good except rye. The sows have alfalfa hay in winter. They have plenty of exercise, good dry sleeping quarters well bedded. Rye straw makes the best bedding.

Charles E. Sutton, Russell, Kans.—My sows are fed principally on mill feed—shorts, middlings, and bran—with practically no corn, and are allowed a large pasture, sowed to rye, rape, or sorghum. About three weeks before farrowing, they are put in separate yards, 20 by 40 feet each, with a 7 by 7 foot house with a board floor and a safety rail 8 inches from the floor.

C. A. Stannard, Emporia, Kans.—I give them the run of a pasture and feed enough to keep them in good, strong condition (not too fat)—a mixed feed made into slop about as thick as porridge. I mix 1 ton of feed as follows: 600 pounds wheat shorts or low-grade flour, 600 pounds ground oats, 200 pounds oil meal, 600 pounds corn chop; mix with water.

J. P. Davis, Fairview, Kans.—At breeding time we separate the brood sows from the others and feed at least one feed of slop, made mostly of bran—two-thirds, and one-third shorts or corn meal. In cold weather this is cooked and fed warm; in warm weather it is soaked for about twelve hours before feeding.

Theo. Louis, Louisville, Wis.—As a rule, we feed 2 parts of shorts to 1 of corn; steam cut clover, mix the above grain with it and feed warm. We feed more or less roots. We separate the old and young sows at feeding time and feed once a day.

George Wylie, Morrisonville, Wis.—During the entire period of gestation our sows are fed on a ration consisting of oats, shorts, and corn in about equal parts, each fed separately; the oats are fed unground and are spread thinly on a tight floor. There are two or three meals or more of roots each week, the amount increasing as farrowing time approaches.

G. W. Plank, Laird, Minn.—I feed a variety of feed, such as corn, oats, and shorts, with a small portion of flaxseed meal, made into a thin slop, with such kitchen slops as are at hand. There is plenty of room for exercise.

Lewis Pond, Churchs Ferry, N. Dak.—I feed bulky feed, such as ground oats, mangel-wurzels, carrots, etc., and am careful not to feed too much greasy kitchen swill, as it will make sows too fat. I see that the sows always have a dry, clean bed. Plenty of exercise is the tonic for health.

G. E. Dyksterhuis, Granada, Colo.—In winter I feed one-half pound ground wheat and one-fourth pound of oats and corn each, ground and mixed into a thick swill, morning and night. I feed sugar beets at noon and as much fourth-cutting alfalfa hay as they will eat clean, with an abundance of fresh water. I give them plenty of exercise and see that their bowels are in good condition. To prepare sows for farrowing (and to keep hogs in condition at any other time), I give them free access to a box of corncob or wood charcoal, mixed with salt and sulphur and sprinkled with a solution of copperas.

James Bolinger, Brush, Colo.—For March pigs I prefer to let the sows have 160 acres or unlimited range, with first-cutting alfalfa cut before blooming, or third cutting, to run to, and give stock barley or corn enough in the evening to keep them thriving. For September pigs my sows have the run of a good alfalfa pasture; with one-half to three-fourths pound of corn soaked and fed at night, so that they will eat it and lie down; otherwise, the green alfalfa seems to carry the corn out undigested.

Stone Brothers, Manhattan, Mont.—We give plenty of exercise by letting them run in a large pasture and giving enough slop and grain in addition to keep them in fair condition.

William Stufft, Kalispell, Mont.—I feed screenings from the elevator, bran and shorts equal parts (dry), with plenty of clear water handy, feeding twice a day. The sows run in pasture and sleep in an open shed on the ground.

G. W. Cooper, Moscow, Idaho.—I give slop and carrots or roots of any kind and plenty of good green pasture, never feeding wheat or corn to sows before farrowing time, as they are more apt to eat their pigs as a consequence of such feeding.

Hazelwood Company, Spokane, Wash.—We give a small grain feed daily, with a feed of roots and beardless barley in the sheaf. Sows are allowed a full run and get plenty of exercise.

John Redmond, McMinnville, Oreg.—I let my breeding sows run on clover pasture or wheat stubble fields, with a feed of chopped oats (two-thirds) and chopped wheat (one-third), night and morning, and plenty of running water.

S. B. Wright, Santa Rosa, Cal.—Young sows that are intended for breeders are fed liberally on grain where they can and will take plenty of exercise; they get green feed or squash, pumpkins, or apples until served and safe in pig. They are usually 8 months old when bred, and weigh 250 pounds or more and have large frames. After this they seldom get any grain until after farrowing, but have good pasture of grass, clover, or whatever I can provide conveniently in the nature of green feed.

Sessions & Co., Los Angeles, Cal.—We have little or no pasture, but intend to keep sows supplied with fresh-cut alfalfa and pumpkins, beets and citrons (stock melons) in their season. We feed skim milk when we have it, and a portion of shorts or ground wheat.

M. H. McCord, Bakersfield, Cal.—I feed sows a liberal mixed ration of shorts and ground oats, which produces a strong, thrifty pig. I keep sows in a thrifty condition, not fat. As this is an alfalfa country, I have had good results from sows which were not fed anything but what they ate in pasture.

Thomas Waite, Perkins, Cal.—When grass is plentiful they run on grass and make their own living on pasture. I find the refuse of fruit a good thing for hogs.

FARROWING TIME.

Sows vary little in the period of gestation. This period is about 112 days from the date of breeding. This date should be known, to avoid mistakes that may result in loss of pigs. As the time for farrowing approaches the sow should be watched carefully, in order that assistance may be given if necessary. If she has already farrowed a litter, and has been properly fed and cared for during pregnancy, little difficulty may be expected. With young sows, particularly those bred at an immature age, there is a considerable element of risk at this time, not only to the pigs but to the sow herself.

The bedding of a sow at farrowing time should be sufficient only for cleanliness and dryness. If furnished in large amount the pigs will burrow into it and get lost or be crushed. The best bedding is rye straw and wheat straw, and if the straw is cut it makes an almost ideal bed. Chaff is excellent if it can be obtained. Oat straw is not so valuable.

The management of sows during farrowing will depend largely on the animal and on the weather conditions. Assistance should be at hand if needed, but the sow should not be helped if she is getting along nicely alone. Many pigs are lost annually by lack of attention during farrowing; but, on the other hand, there is no doubt that in many cases overanxiety and too much attention may do more harm than good and often result seriously. The assistance that is imperative at this time is to help in cases of difficult labor and to protect pigs from chilling in cold weather. The temperament of the sow should be considered; some are plainly annoyed by the presence of an attendant and show it in their nervous actions; others may be positively ill natured and resent interference. Such sows are better left alone during farrowing, and should be bred to farrow when warm weather may be expected; so that the chances are as much in favor of the pigs as possible. If the sow's nervousness or ill nature leads her to eat her pigs, the best remedy is to put her in the pork barrel at the earliest opportunity.

When farrowing occurs during warm weather, a minimum amount of attention will be needed. The pigs are less likely to become chilled at this season and will generally find their way to the teats unaided. Proper preliminary feeding of the sow and good quarters will make the chance of trouble small. On the other hand, if a sow farrows during extremely cold weather the pigs will be in danger of being chilled unless the house is heated. To remedy this some breeders throw a blanket over the sow until she is through. Others place a few hot bricks or a soapstone in the bottom of a basket or barrel, covering them with straw, and put a cloth over the top to prevent too rapid radiation; and, unless the sow objects too seriously, the pigs are placed in this receptacle as fast as they arrive. They will not suffer if they do not suck for a few minutes, and they will be dry and warm when placed to the teats. This treatment will be necessary even in warm weather with sows that are nervous and move about during farrowing. When farrowing is over the pigs should all be placed to the teats, care being taken that each one gets his share. When the afterbirth is passed it should be removed at once and burned or buried. There is good reason to believe that the eating of the afterbirth is often the beginning of the habit of eating the pigs that is so troublesome with some sows.

In very cold weather it may be necessary for a few days to remove the pigs to a warm place after they have sucked, to prevent chilling. As new-born pigs suckle as often as every two hours during the day, this entails considerable inconvenience; but it is time well spent and may mean the difference between profit and loss to the breeder. The pigs are soon able to fight their battles with the cold unaided by any but their own warmth and that of the dam.

For the first twenty-four hours the sow should, as a rule, have no food, and will need none. If, however, she shows signs of hunger, a thin slop of bran and shorts or a thin oatmeal gruel may be given. Tepid water should be given to drink as the sow wants it. Never give cold water.

The feeding for the first three or four days should be light and carefully given, and the time consumed in getting the sow on full feed should be from a week to ten days, depending on the size and thrift of the litter. The first feed should be very light, and in the form of a thin, warm slop, such as is mentioned in the preceding paragraph, working gradually to full feed. The pen should be cleaned daily if the sow is confined to it.

OPINIONS OF BREEDERS.

The following were among the replies to the question "What is your management of sows at farrowing?"

George Aitken, Billings Farm, Woodstock, Vt.—In summer all brood sows run to pasture where there is abundance of shade and water; in the winter they are kept in pens with a concrete floor covered with cut-straw litter; have yards for exercise, with a stream of water running over the concrete; are fed very little grain, the feed being principally dairy swill and plenty of beets fed raw.

Smith Harding, Westfield, Mass.—They should be kept by themselves for a few days to get accustomed to their new home. I feed rather light feed a day or two before farrowing and nothing but water for the day after. I also feed rather lightly until the appetite is fully restored, then add milk, if I have it, with middlings, ground oats, and other light feeds.

A. M. Lyman, Montague, Mass—The sows are divided off into breeding pens about two weeks before farrowing. These pens are 6 by 8 feet, with a railing around the inside 10 inches from the bottom, so that the sow can not lie on the pigs. I bed with shavings.

Richard H. Stone, Trumansburg, N. Y.—I put them in warm pens about 8 by 8 feet, with a fender around the side about 8 inches from the floor; have an attendant with them at farrowing, and always keep a lantern lit at night and hanging in the pen; then the sow will not lie on the pigs.

Edw. Van Alstyne, Kinderhook, N. Y.—The sows have a quiet place by themselves, to which they have been accustomed for at least a week. Not too much of fine, dry bedding. The niches of the pen are protected by planks so that the sow can not lie close to the niche and so lie on the pigs. No feed of any kind is given for at least twenty-four hours after farrowing—just a little warm drink; then light, warm feed in small quantities, until the pigs begin to demand the milk. If constipated, the sow is given one-quarter of a pound of Epsom salts. If the above system is observed, this will not often be necessary.

D. J. Warbasse, Newton, N. J.—Seven to ten days before due shut the sow by herself and give a good bed of straw, so that the pen will be well lined before farrowing. Feed a little corn, with bran and middlings and some roots. At farrowing leave her alone, unless something is radically wrong, and feed lightly for a few days. Do not disturb a sow for say twelve hours.

F. W. Lewis, Chaddsford, Pa.—If the sow is careful, I do not disturb her or feed for twelve and sometimes twenty-four hours; with sows that are not to be trusted, I remove the pigs at once and keep them away until farrowing is over; then let them nurse and put them to the sow every two hours until four days old, when longer periods elapse.

J. S. Burns, Clinton, Pa.—As long as convenient before farrowing each sow has a separate pen and lot (we use portable pens). Never confine her until she begins to make bed to farrow. Everything is made clean and the sow closed in the pen. We treat her in such a way that we can go in the pen and stay with her if need be. No feed of any kind is given for twenty-four hours, then a drink of milk diluted with water. We then begin feeding, lightly at first, and feed for the first four weeks about the same as the four weeks before farrowing. If farrowing comes in April pasture will be at hand and corn may be added, making the ration about 1:6½. When the pigs begin to eat, provide a trough by themselves and feed them skim milk at first, then add oil meal and mill feed.

R. L. Munce, Canonsburg, Pa.—I have them in pens by themselves at least one week before farrowing; put in chaff for bed (not much); put a guard rail around the pens to keep the sows away from the wall and give the pigs a chance to get under; feed lightly at first, increasing the feed as the pigs get older, feeding a slop made of equal parts of bran and shorts (by measure) with one-tenth part (by weight) of oil meal.

John Snowden, Bowie, Md.—My sows are put in warm, sheltered pens, 8 by 16 feet, 8 by 8 feet of which are plank floors, the remainder dirt, about ten days previous to farrowing. They are supplied with leaves and fine straw for bedding, but not too much.

Chas. A. Kuhlmann, Hamilton, Va.—Two or three days before farrowing I put each sow in a pen by herself. The pen is about 8 by 16 feet, divided into two parts, and the sow is allowed to have free access to both. The house has shelves or boards nailed around on the inside from 10 to 12 inches from the floor, projecting about 5 or 6 inches from the walls, thus making an escape for the pigs should the sow get the pigs between her and the house and lie down. I give a liberal amount of wheat straw for bedding and keep a close watch. When I think the sow is about ready to farrow I close her up in the house and arrange to be with her at farrowing. Sometimes she becomes very restless, and in her misery may get up and down very often and hurt her pigs, but when she begins to get restless if rubbed on the breast she will usually lie quietly. As soon as the little fellows are born I break off the navel cords about 2 inches from the body: do not cut. This prevents navel rupture and often saves the life of a pig, as the sow may lie on the long cord and then overlie the pig. After the sow is through farrowing and the afterbirth is thrown away, I leave her. I feed her very lightly for about three days and then begin increasing the feed until she is on full feed again, which is in about ten days. I give the sow her first few feeds in the house, but begin feeding in the pen as soon as conditions are favorable. Clean out the house about three days after farrowing, and see that the sow and pigs have a good, dry bed.

Sam T. Smith, Troy, Ala.—If the weather is rainy and cold I make them a good nest in a stable and put them in there two or three days before due, but if the weather is good I let them choose their own places in the woods or straw fields. In either case I stay with them until they get through, and always keep a close watch on them for two or three days, hardly ever losing a pig.

W. E. Davis & Bro., Sherman, Tex.—About two weeks before farrowing we put the sow in a pen by herself. In this pen is a good warm house, with straw for a bed. We feed the sow on the kind of feed we want her to have after farrowing, which is corn and shorts slop, both night and morning. Be on hand at the time of farrow to see that all goes well and see that each pig has sucked before we leave. We give the sow nothing to eat for the first twenty-four hours, only water; then give a thin slop and some alfalfa hay to fill up on. We are careful not to feed too much, as this is the most critical time in the pig's life, and if the sow is overfed it causes too large a flow of milk, and this causes scours in the little ones and is often death to them. We have been raising purebred hogs for several years and find that if we can get them two weeks old, we can raise nearly all of them.

M. C. Abrams, Manor, Tex.—Ten days before farrowing I fasten each sow in a pen by herself, about 10 by 20 feet, one-half of which is shedded. Feed a light swill diet until four or five days after farrowing, then increase the feed so as to give the full amount by the time the pigs are 10 or 12 days old. The feed is wheat bran and corn meal for slop—oats and corn for grain.

Clifton Chisholm, Roswell, N. Mex.—As near to farrowing time as possible I put my sows in separate pens which have running water in a trough and are half closed and half open, and feed them a very little slop made of shorts. After farrowing the feed is increased and a little Kafir corn added. About two weeks after farrowing I remove sow and pigs to alfalfa pasture.

H. P. Wilson, Gadsden, Tenn.—I try to get their systems in tiptop shape by farrowing time; they then need very little help through that period. I have never owned a sow that needed any aid, although I always try to be near at hand. After the pigs are dry and suckle I water the sow, and in twelve to eighteen hours give her a good feed of thin slop; in ten days I have the sow and pigs on green pasture.

J. S. Henderson, Kenton, Tenn.—About two or three weeks before farrowing each sow is given a lot to herself, with a comfortable house to sleep in. At farrowing time I watch them very closely until I see that the pigs are sucking all right. I do not get my sows on full feed until the pigs are a week or ten days old, and then feed as before farrowing.

Geo. W. Dozer, Roseville, Ohio.—I feed nothing for the first two days except water with the chill off, after which I add a little wheat bran and increase the rations of bran, middlings, and crushed oats, made into slop and fed in troughs, as much as will be eaten with avidity without dulling the appetite.

N. P. Kershner, Ansonia, Ohio.—One to two weeks before farrowing each sow is placed in a small yard with a farrowing hut, and is watched closely to give assistance if needed. During the first twenty-four hours nothing is given but a drink of water with the chill off; then bran is given in milk or water, at first 1 quart at a feed, increasing to 1 gallon at a feed, twice daily, about a week after farrowing, when a little middlings may be added to the bran. The pigs are watched closely, and if any signs of scours appear the middlings are removed a little longer and then added slowly. At three weeks I can commence to feed one ear of corn twice a day, if the sow has a large litter, increasing as the pigs can stand it. At about five weeks the pigs will begin to look for something to eat, which should be provided where the sow can not molest them. It is a little milk at first, then a little wheat middlings in the milk, then a little shelled corn for them to crack, keeping up the milk and middlings and increasing the feed as they are able to bear it, but never overfeeding.

F. P. & J. J. Hardin, Lima, Ohio.—About two weeks before farrowing we remove them from the herd to a small lot containing a farrowing house, with a floor in the east end and a large window on the south. The roof is so constructed that we can raise part of the south side to let in the sunshine; we also get the morning sun through the door, and consider sunshine the most essential feature for spring pigs. We feed the sow very lightly for a week or ten days after farrowing, then increasing to full feed.

M. L. Bowersox, Bradford, Ohio.—When the little fellows begin to come I am present with the sow, and as fast as they come place them in a box. When all have come I place them to the sow and help them to suck, putting them back in the box when they have satisfied their appetites, and letting them take a nap. While the little fellows are away from the sow, so that the operation does not disturb her, I break their little teeth with small nippers, so that when they are suckling they will not bite the sow's teats and disturb her; care must be exercised in this that little pieces of the sharp teeth do not go down the throats of the pigs. I then put them to her and make it my business to look after them for a few days; when I hear the sow giving suck, I go and assist the pigs, especially if the litter is large, and by this method I have had sows raise litters of fourteen pigs and all to do well, but they must be helped in the start.

Aaron Jones, jr., South Bend, Ind.—About one week before farrowing each sow is put in a small pen and kept there for one week after, when I turn her and the litter out on grass and let them run together until the sow ceases to look after the pigs, and they wean themselves by natural methods.

Jacob Polley, Union City, Ind.—Most sows will do better at farrowing with no one present. Most persons are too anxious about the sow's welfare and do more harm than good. I have watched many of my sows farrow, and the most good I have done was to see that the coating was removed from the pig's nose so that it could start breathing. If a sow is able to farrow that is the most she needs. A few times when the sow had difficulty I have had to pull the pigs, and in such case the hands are the best instruments I ever saw, as they are not dangerous.

T. B. Pearson, Thorntown, Ind.—One week previous to farrowing time place each sow in good, comfortable quarters, so that she may get accustomed to the same by the time she is due. Handle her often, get her gentle, and feed a slop made of shorts and ground oats, but little corn. Give her a good bed, but not so much that she will pile it up and overlie the pigs. Do not disturb her to feed for eighteen hours after farrowing; let her remain quiet. Feed warm bran slop sparingly for one or two days, as there is great danger at this period of producing too much milk flow and giving the pigs scours.

James D. Kiger, Charlestown, Ind.—After the sows farrow we give no feed of any kind for twenty-four hours, but give all the water the sow will drink, as she is very feverish at this time. From then on we give ground feed made into a slop, the same as before the sow farrowed, a mixture of equal parts of hominy meal and ground oats, or a mixture of 2 parts bran and 1 of shorts, the slop being made thick enough to pour. Feed lightly for the first ten days, to prevent scours in the pigs from too much rich feed. When we are certain that there will be no trouble from this cause we put the sow on a full ration and feed some corn. With this treatment the pigs can be weaned at eight weeks old, when they are ready to go on rye or clover pasture.

Thomas Bennett, Rossville, Ill.—Put them in a single house with plenty of bedding. The quieter they keep the better. If they do not move for a day or two after farrowing so much the better. I have known them to lie in their beds for three days without any feed or water. Feed a little thin shorts slop, as little as possible, so as to keep the sow quiet.

A. J. Lovejoy & Son, Roscoe, Ill.—Give no feed for twenty-four hours, but give them what water they will drink, then commence to feed gradually and increase as the pigs are able to take all the milk the sow gives. After a week give the sow all she can eat of milk-producing feed.

H. M. & W. P. Sisson, Galesburg, Ill.—A few days before farrowing the sows should be put in separate pens, so arranged that they can be turned out every day for exercise. They should be fed moderately on feed that will not constipate them. After the sow has farrowed she should not be fed for perhaps two days, but should be supplied with plenty of water. If inclined to be constipated, a light bran mash fed a few times works very successfully. She should be fed moderately for a few days, gradually increasing the amount up to full feed. She should still have opportunity for daily exercise. When the pigs are about three weeks old they should be fed in an adjoining pen, where the sow can not interfere with them. The sow and pigs should have access to a good pasture as soon as there is grass.

J. D. Orn, Mount Pleasant, Iowa.—Have them in good, dry quarters, watch them closely, and if cold I put a blanket over the sow and pigs until the sow is through pigging. The sow is given a good feed before she commences to farrow.

W. L. Niles & Son, Ames, Iowa.—Each sow is provided with good, dry, comfortable quarters, fed nothing but water for a day after farrowing, and then put on feed gradually, when she is fed all she will eat of corn and sloppy feed largely made up of wheat shorts. In season all sows have the run of pasture.

W. A. Jones, Vanmeter, Iowa.—The sow is put into the farrowing pen a week before farrowing and fed light feed, but very little, if any, corn. The farrowing pen should be dry and clean, with a moderate amount of bedding, which should be changed often. The pen should be arranged to let in the sun when there is any. If the sow is restless and careless, stay with her and take the little fellows away from her and put them into a barrel that has been prepared with some nice dry straw and two or three hot bricks under the straw; cover the barrel, leaving an air hole. When the sow is through her trouble, get nicely acquainted with her and quietly put the little ones with her. If they nurse all right and the sow is quiet and comfortable, go away and let nature do the rest. Do not give the sow anything to eat; give warm water—dishwater is best. On the second day, mix a little bran and shorts with water; the third day the same. Watch carefully whether your sow is a heavy suckler and feed accordingly.

W. M. Lambing, West Liberty, Iowa.—I put each sow in an individual house, to which is attached a small lot. The house is 7 by 8 feet, with fenders around the sides. I try to be with the sow when she farrows, and keep her in the house until the pigs are four weeks old.

F. F. Failor, Newton, Iowa.—Sows are kept in separate pens, as near the ground and as free from drafts as possible. They are fed very lightly from the day of farrow for a few days, with a gradual increase of feed as the pigs grow older. The pigs have plenty of exercise and sunlight, and, above all, a dry and clean bed.

M. H. Donelson, Ogden, Iowa.—I have a house standing north and south, with pens 8 feet square on either side of an alley 4 feet wide. The pens have fenders or pockets around the sides to keep the sow from hurting the pigs. As soon as they get old enough I have them on grass. They must have exercise.

Thomas Teal & Son, Utica, Iowa.—We feed nothing for forty-eight hours, except some weak slop of some kind, putting in a small amount of oil meal, increasing a little every day, with a feed composed of oats, wheat, rye, oil meal, and a small amount of ground corn, fed in slop.

L. L. Young, Oakland, Nebr.—Give nothing but water for the first two days; feed lightly for the first week, then increase to not quite full feed. The sow is kept in a farrowing pen and the pigs allowed to go out and in at will for two weeks, then the sow is turned out for exercise about one hour a day, at which time the pigs are kept in. At this time the sows have access to some green pasture. I do not like to have sows or young pigs out on pasture in cold, rainy time.

C. H. Searle, Edgar, Nebr.—We have them in a good warm pen with a good bed. If the weather is cold we have a stove in the farrowing pen with which we keep the room good and warm. We stay with the sow when farrowing.

J. V. Wolfe, Lincoln, Nebr.—If quiet, attend the sow and remove the pigs to a corner or other place of safety with as little noise as possible until the sow is through. If cold, dry them with a cloth and hand rub them. Clean up the litter, give dry bedding, return the pigs, and assist them to their first dinner.

A. T. Shattuck, Prosser, Nebr.—Put sow in farrowing pen 8 by 8 feet, with fenders around the pen. Be there to take care of the pigs if necessary. Feed lightly for the first few days. Right here is where you must mix in brains.

T. J. Congdon, Pawnee City, Nebr.—About a week before farrowing I shut each sow up by herself so that she will get used to her quarters. I give them plenty of good, clean straw. I know that this is contrary to the ideas of professional breeders, but my experience has been that if you give a sow a good lot of bedding she will pile up her nest and crawl into it, get herself out of sight if possible, and very rarely ever get up or come out until she is through farrowing. They will often lie twelve to sixteen hours without stirring. I always place water where they can get it when they first come out. When you give only a small amount of bedding they are apt to keep getting up and down and often kill their pigs. I give nothing to eat for the first twenty-four hours, then give a little thin slop, increasing gradually until you get her on full feed, which will take from ten days to two weeks, as the pigs begin to draw on the mother. I give them the best and richest feed I can get for them. (Don't change their feed unless you do it very gradually.) I know that this is contrary to the opinions of most breeders. They claim it will give the pigs the scours, but if you will commence slopping the sows before farrowing, and are careful about changing feed and give them a dry, warm place to sleep and keep them out of the damp cold and wet, I will risk the scours. More pigs have scours from having a wet place to sleep than from any other one thing.

S. W. Schooley, Cozad, Nebr.—Put the sows in separate pens a week before the time to farrow. Have the pen about 7 feet square, with fenders around the sides, then when the time for farrowing comes be on hand and look after the little fellows. Put them in a box, keep them warm, and they will soon dry. When the sow is through farrowing put them with her, rubbing her, and see that the pigs get a good dinner.

R. C. Marshall, Arlington, Nebr.—I have the date of breeding and know just when they will farrow. I shut them up two or three days before farrowing. After they farrow, I feed no grain or slops for twenty-four to forty-eight hours, then feed lightly, and get them on full feed in five to eight days. Try to have the sow gentle and quiet and be with her at farrowing. Remove the pigs as fast as farrowed until all arrive, then put each to a teat and see that all nurse and get filled up. Allow very little bedding. Give the sow a warm slop with just enough bran (say 1 quart) for the first twenty-four hours to sweeten the water, then increase gradually.

H. W. Cheney, North Topeka, Kans.—Have box stalls 8 by 12 feet for each sow. Unless the sow is very large she gets little attention. In the case of big sows, we remove the pigs to a box and keep them there several days, allowing them a chance to suck five or six times a day.

Newton Bros., Whiting, Kans.—Put in clean farrowing pen and keep them quiet. Be on hand to attend to it in person. Never get mad and use them roughly. Never assist unless absolutely necessary, then use judgment and care. Get pigs to nursing, and then clip tusks. Give the sow plenty of pure water but no grain for twenty-four hours. Use common sense and favor nature in every detail possible.

John D. Marshall, Walton, Kans.—Shut her in a warm pen two or three days before farrowing time, giving only a little bedding. Have your sow perfectly quiet, so that you can work with her and the pigs without exciting her. Clean out all the bedding the second day after farrowing, sprinkle the pens well with air-slaked lime, and change the bedding every two or three days.

M. H. Alberty, Cherokee, Kans.—Put sows in a tight 8 by 10 house with fenders: feed nothing for twenty-four hours after farrowing, but give small quantities of lukewarm water often. The second day after farrowing feed lightly on the same kind of feed that the sow was used to before farrowing, and let her out to exercise every day.

L. L. Frost, Mirabile, Mo.—I use a single pen, affording dry, warm quarters. In cold weather I stay with the sow until the pigs have sucked once. Do not feed the sow for twenty-four hours and do not give her all she will eat until the pigs are ten days old.

Evan Davies, Keytesville, Mo.—I have them farrow in 8 by 8 foot pens, using a guard rail fastened 12 inches from the wall and 8 inches high. I use very little bedding until the pigs are a week old, cleaning the pens out daily, using air-slaked lime on the ground before putting fresh bedding down. At farrowing time I feed shorts slop mixed with clear water.

F. M. Lail, Marshall, Mo.—A few days before the sow is due to farrow, I shut her in a small lot attached to the farrowing house and reduce her feed, using only ship stuff and bran, equal parts by weight, mixed with water. Have the bowels loose, and there will be no trouble at farrowing nor danger of the sow eating her pigs. After farrowing, I give nothing but water for twenty-four hours and a very light feed of the swill named for two or three days more; then I gradually increase the feed until the sow is on full feed in a week.

W. O. Wilson, Okemos, Mich.—If the weather is cold, stay right with her and see that the pigs do not chill, but get dry and have something to eat. Give the sow nothing but drink for the first twenty-four hours, and feed sparingly for a week or two, according to the number of pigs in the litter. Increase the feed with the increase of the demands of the pigs on the sow.

W. H. Lessiter, Pontiac, Mich.—I always try to have my sows very tame, so that I can be right in the house with them when they farrow. I use individual hog houses, 6 by 8 feet, with a fender around the inside. If the sow is uneasy when farrowing, I put a board across the house about 2 feet from the back end and resting on the fender; this makes a first-class farrowing pen.

D. S. & F. Smith, Belleville, Wis.—We have a few little houses, 5 by 7 feet, which we consider fine; put the sow in a few days before her time; feed mo on slop up to farrowing, then lightly until the pigs begin to draw on the dam, then increase to all she will eat up clean. We feed fine middlings or flour, middlings and bran, or ground barley and oats, each one-half, for slop.

George Wylie, Morrisonville, Wis.—We put them in safety pens that they can not turn around in, thus preventing them from overlying their pigs; as a rule we keep from them and do not offer them anything to eat until they get up and look for it, then give them a drink of thin slop.

F. E. Rutter, Ferryville, Wis.—For the first twenty-four hours I feed only a little bran, say, 1 pint in a gallon of water twice a day; then increase the amount of bran and give oats gradually, getting them on a full feed of bran mash by the time the pigs are a week to two weeks old, according to the size of the sow and the number of pigs, giving all the oats they will eat after their meal of bran mash.

Theodore Louis, Louisville, Wis.—I keep a record of each sow when bred and feed her two weeks before farrowing in her pen alone on the same food that she has been fed up to the time to farrow.

Thomas H. Canfield, Lakepark, Minn.—Keep the sows quiet; have a man in attendance in case of help being needed; in cold weather take away the pigs and keep them warm until all are farrowed; care depends greatly on the temperament of the sow.

C. H. Murphy, Caledonia, Minn.—I prefer to have the sow running around the barnyard or in the pasture until about her time to farrow; sows farrow more easily when they have had plenty of exercise. I put the little ones in a box until the sow is through farrowing, then I bring them back a couple of times to feed before they are left entirely.

O. R. Aney, Wilmot, S. Dak.—The sow is fed on a thin slop composed of shorts and bran from the time of mating to farrowing time. Just before farrowing she receives a liberal feed of oil cake or about a gill of raw linseed oil; this produces an easy farrow. I never feed anything for the first twenty-four hours, but give the sow a drink of water. If she is fed at this time it will cause too large a flow of milk, and the little fellows will not be able to take it all; this will remain in the udder, causing milk fever, and it will also produce white scours in the pigs.

G. E. Dyksterhuis, Granada, Colo.—I place each sow by herself two weeks before farrowing and feed to keep her gaining just slowly up to two days before farrowing, then give her laxative feed and no grain for the next twenty-four hours, then increase the feed slowly. I am always on hand at farrowing and place the pigs to the teats right away, and stay there until the pigs can take care of themselves. I clean the beds twice a day. My farrowing pens are 6 by 8 or 8 by 10 feet, with fenders 6 inches wide placed 6 inches from the floor all around the pens. There is a window on the south side, air-tight, with ventilators to open if necessary. A yard is provided for each sow and litter in winter and pasture in summer. I feed my sows to a certain extent according to the size of the litters they have and the milking qualities they possess. While I never retain a poor milker, still some sows have rich milk while others give a larger amount of poorer quality. I study the characteristics of all my hogs, and breed for the best results as much as possible.

James Bolinger, Brush, Colo.—I have each sow shut up in a pen 8 feet square a few days before she is due to farrow, and try to be around at farrowing until she is entirely through; then I do not feed any for twenty-four hours. When passing I am careful not to disturb her.

William F. Stufft, Kalispell, Mont.—Shut the sow in hog house on floor in stalls 6 by 8 feet, with rails inside 6 inches from the walls and 8 to 12 inches from the floor. Bed with straw or hay; put in fresh bed every other day. Give sow plenty of water; feed sparingly for the first week on bran or oats.

G. W. Cooper, Moscow, Idaho.—I generally give them a good, dry place to themselves a week before the time is up to pig, and feed them swill and roots before farrowing. After farrowing, I feed bran and shorts mixed with the slop or fed wet with water. Keep the sow confined in the pen until the pigs are a month old, but have a hole for the pigs to run out and in for exercise.

Harry McQueen, Pomeroy, Wash.—I shut each sow by herself in a close pen with a good, warm shelter and plenty of dry straw for bedding, and feed them well. When they farrow, I never disturb them until they get up to eat; then give them all they will eat of a sloppy feed of ground grain soaked in water or house slops. Then they will likely be quiet until the next feed hour and are not apt to lie on the pigs or hurt them by getting up and stirring around.

John Redmond, McMinnville, Oreg.—I inclose sows in pens 8 by 10 feet with a 2-by-4 inch scantling around the pen, 8 inches from the floor and 8 inches from the wall, with cut straw or chaff for bedding. The sows are turned out in a lot daily for exercise; if they are watched closely, nearly all the pigs can be saved.

William Durrell, Gresham, Oreg.—When a sow shows signs of farrowing, I am on hand, and as my sows are quiet, I take the pigs as they are farrowed and place them in a box with hot bricks in the bottom, until they are all farrowed and dried off; then I let them all nurse at once.

S. B. Wright, Santa Rosa, Cal.—About one week before farrowing the sow is put into a pen 12 by 24 feet, with a box stall 8 by 12 feet attached. When she is due she is confined in the box stall, if it appears that she is about ready to farrow, and watched. Care is used so to feed that an excessive flow of milk will not be produced. Some pains are also taken to prevent constipation in the sow.

Fred Miller, Dospalos, Cal.—Sows are confined in pens about 8 by 16 feet, without bedding, and are not allowed anything but water for twenty-four hours after farrowing, after which the feed is increased gradually to the desired amount, which is about 2 pounds grain, barley, or wheat mixed with chopped alfalfa hay, and then soaked in skim milk or water. When possible, all the green alfalfa they will eat is added.

M. H. McCord, Bakersfield, Cal.—As a rule, I put the sows in separate pens a few days prior to farrowing, so as to become acquainted with their surroundings. I place a fine quality of hay in the pen, and let them make their own nests, as they know more about such things than I do; this done, they are quite at home. When the little ones come, if any of them are weak, I assist them to get their first feed, and after that everything is plain sailing. I never use violence with my hogs, especially with my brood sows, and I find that there is no domestic animal that responds so quickly to gentleness as the hog. I go among my hogs frequently, talk to them, and keep up a friendly acquaintance with them.

THE SOW A MOTHER.

No time should be lost after farrowing in getting the sow into the open air. Of course, if the pigs were farrowed during the winter months care will be needed, and it may be necessary to let the pigs reach the age of two weeks before turning them out. They can, however, get considerable exercise in the piggery or in the lot with sow, and there is often a lot adjoining a barn that is sunny and sheltered from cold winds where the new family may be turned for exercise. Avoid particularly allowing the pigs to run out during a cold rain. They are especially tender during the first weeks.

The appetite for something besides the dam's milk may begin to assert itself by the time the pigs reach three weeks of age. This time will vary, of course, some pigs being more precocious than others. They will be noticed nibbling at grass, rooting a little, and even investigating the sow's feed. A pen should be arranged adjoining that of the dam and separated from it by a partition with sufficient room at the bottom to allow the pigs to run under. In this inclosure put a low, shallow trough and place in it a little skim milk or a thin gruel similar to that recommended for the sow the first day after farrowing. This gruel may be made with any concentrate that is free from woody matter. If ground barley or oats is fed, the meal should be first sifted to remove the hulls. There is a great variety of feeding stuffs that can be used. The main point to be observed is that the pig's stomach is very easily deranged at this age and feeds must be given that will digest readily. The trough in which the pigs are fed should be kept clean. No stale feed should be allowed to remain in it from one feed to the next.

As the pigs learn to eat, the feed may be increased. Skim milk should be used liberally, using rather large quantities at first, from 6 to 12 pounds of milk to each pound of grain. During this period comparatively little corn should be fed, as a rule. More growth can be obtained with a narrow ration, and the corn should be withheld until the fattening period comes. The pigs should be kept growing constantly, and the best results will come with feeding a little under their capacity rather than all they can consume. To counteract the tendency to become too fat, they should have plenty of exercise.

Scours and thumps often cause very serious losses among young pigs. The former is caused usually by overfeeding, by feeding badly spoiled feed, by an abrupt change of feed, or by a change in the feed of the dam that affects her milk. Thumps is generally caused by overfeeding and lack of exercise.

WEANING.

If the pigs have been properly managed for the month after they first begin to eat, and are taking feed in amounts sufficient to make them more or less independent of the sow's milk, weaning will not be a difficult process and will be brought about so that it will be scarcely perceptible, so far as the effects on the pigs are concerned. The time to wean will depend on the way the pigs are eating and the convenience of the breeder. If they are not thoroughly accustomed to a grain and skim milk ration, the time must be delayed, and if there is no occasion for breeding the sow no harm is done by allowing the pigs to run with her to the age of twelve weeks or older.

Breeders differ widely as to the age of weaning. The majority wean at six to ten weeks, with a considerable number at twelve weeks; some older than twelve weeks, and a few younger than six weeks. The 398 breeders of purebred hogs, situated in all parts of the country, who stated definitely the ages at which they weaned their pigs, reported their practice as follows:

As early as 4 weeks of age	13
Not before 6 weeks of age	67
Not before 7 weeks of age	2
Not before 8 weeks of age	161
Not before 9 weeks of age	3
Not before 10 weeks of age	93
Not before 12 weeks of age	59

Those breeders who wean at the age of four weeks are generally in the States classified on page 249 as the East and New England. The breeders who wean at the early periods usually are situated where dairy by-products are plentiful and they usually raise two litters each year, making the demands of the pigs on the sow as brief and light as possible. Breeders in the corn belt wean at the more mature ages, rarely weaning as young as six weeks, and often allowing the pigs to reach the age of sixteen weeks before the sow is taken away. A considerable number of men make no attempt to wean, as the word is generally used—that is, there is no enforced separation of the sow from her pigs; the pigs run with the sow until her instinct tells her that they are old enough to shift for themselves.

The method of weaning will depend somewhat on circumstances. If the pigs are so little dependent on the sow's milk that she is gaining rapidly in flesh and lessening in milk flow, the weaning may be abrupt, the sow being taken away out of hearing. If she is still milking considerably she may be returned to the pigs once a day for two or three days, or the pigs may be taken away in detachments, beginning with two or three of the largest and strongest, then the next strongest, leaving the weakest ones of the litter to complete the drying off.

Whether the weaning is brought about directly or gradually, it should in all cases be complete and decisive. The pigs should be placed apart from the sows in quarters secure enough to prevent communication. By no means should pigs be allowed to follow a sow until she is almost worn out. The pigs are no better and the sow infinitely worse than if weaning had been brought about properly.

OPINIONS OF BREEDERS.

The following were among the replies to the question "At what age and how do you wean your pigs?"

Edward van Alstyne, Kinderhook, N. Y.—If the sow is to be bred shortly, I wean at six weeks; if not, I let them wean themselves. If weaned at six weeks, they should have begun to eat a little with the sow. They will suffer if they have not done this. Feed small quantities of warm milk with a little middlings or oil meal in it three or four times a day.

E. R. Strawbridge, Moorestown, N. J.—Between six and eight weeks old. Fasten the mother in the pen and let the youngsters in once in a while if the udder cakes. Feed milk in a shallow trough to the little ones.

Tom Frazier, Morgan, Tex.—At two months, little weaning is necessary, as they are eating heavily of bran, oats, and corn. Then put the sows in close pens and leave the pigs where they were.

M. C. Abrams, Manor, Tex.—About eight weeks. When the pigs are from two to three weeks old I have a trough fixed on the outside of the farrowing pens; open a space large enough for them to come through, and feed milk, meal, and anything else that they like to eat. By the time they are seven weeks old they can do without their mother. I then commence decreasing her feed if I want to wean the pigs at this time, and in a week or ten days she will have weaned them. I always try to have an oat pasture for young pigs to go to.

Clifton Chisholm, Roswell, N. Mex.—My pigs have access to a slop of shorts and corn after they are one month old. I take their mothers away at two months.

J. K. Henderson, Kenton, Tenn.—I usually wean my pigs at twelve weeks old and sometimes at ten weeks old by beginning to feed some slops and milk (if I have the milk) at four weeks old, increasing the feed as they get older; by the time mentioned they wean themselves.

L. N. Jordan, Oakland, Ky.—From ten to twelve weeks. After they are four weeks old I feed them in a small trough by themselves, and at the age of ten to twelve weeks take them entirely from the sows.

O. P. McDowell, Plain City, Ohio.—At ten weeks. By that time the pigs are eating by themselves, and I shut the sow away or remove the sow to a distant pasture if possible, but never shut the pigs up. I place a trough where the sow can not get to it, and as soon as the pigs begin to eat, place a little warm milk in the trough and add a little shelled corn. As they get older I add middlings and finely ground oats; and as soon as the pigs are eating nicely I begin to decrease the slop given to the sow and give her more corn and less milk-producing feed. By the time of weaning, the pigs scarcely miss their mother and are not checked in growth.

N. P. Kershner, Ansonia, Ohio.—Ten to twelve weeks; sometimes eight or nine weeks, but ten or twelve is better; by increasing their feed and decreasing that of the sow, taking all her slop feed away from her and increasing her corn. This dries her up. I shut the sow up to dry off and let the pigs run.

Davis Brothers, Dyer, Ind.—With young sows that suckle down thin, we wean at five to six weeks; with others, at seven or eight weeks.

George G. Garretson, Matthews, Ind.—When the pigs are three weeks old, I prepare a pen that the pigs can crawl into but the sow can not. I place in this pen a very shallow trough in which I feed the pigs skimmed milk, being very careful to remove all that is not eaten before it becomes sour. As the pigs learn to eat, I add a little middlings to the milk; also give them some shelled corn. In this way they are fed all they will eat up clean until they are eight weeks old; then I remove the sow out of sight and hearing of the pigs.

W. W. Milner & Son, Thorntown, Ind.—Eight to ten weeks. Take them away from the sow all at once. Sometimes we return them to the sow in twelve or twenty-four hours to let them suck; then they are taken away for all time.

Thomas Bennett, Rossville, Ill.—I generally let the sow wean them, which they will do soon after being in farrow.

A. G. Woodbury, Danville, Ill.—Ten weeks. If not wanting to breed the sow for a fall litter, I do not wean pigs.

C. R. Doty, Charleston, Ill.—Wean at two and a half to three months—on a clover field if in summer and on steamed shorts or middlings if in winter.

William Walker, Pana, Ill.—In my opinion, weaning pigs is quite important. We wean in eight or nine weeks. As soon as the pigs begin to eat, which is quite soon after farrowing, we give them a little ground corn and ship feed, mixed with milk, in a pen by themselves. This pen is fixed so that they can go in and out at will without being disturbed by the sows. In this way they are hearty eaters at weaning time and can be weaned without trouble or backset. This plan also saves the sow, as the pigs do not worry her so much and she will keep in better flesh. She is removed from the pigs every other day when weaning them, so as to dry up gradually. This is done two or three times and the job is then complete.

J. D. Orn, Mount Pleasant, Iowa.—Let the sow wean them.

W. A. Jones, Vanmeter, Iowa.—I generally let the sows wean the pigs, which will be at about ten weeks old.

William D. McTavish, Coggon, Iowa.—I usually let the pigs wean themselves. They will do this if furnished plenty of feed out of reach of the sows.

M. H. Donelson, Ogden, Iowa.—Twelve weeks. Then never allow them to shrink; give the pigs all the milk you think best.

R. J. Johnston, Humboldt, Iowa.—Let the sow wean them.

B. L. Gosick, Fairfield, Iowa.—At ten weeks old I quit slopping the sows and they soon dry off and the pigs are weaned. Never shut the pigs up, and seldom have to shut the sow from the pigs.

S. McKelvie & Son, Fairfield, Nebr.—Teach the pigs to eat as soon as they will by placing tempting feed before them out of reach of the sow. They will then wean themselves at the proper time and never get a check in growth.

Chas. E. Sutton, Russell, Kans.—At eight to ten weeks. Have them all eating well at a separate trough. Take away all but the two smallest; a couple of days later remove one of these, and later the last one.

Evan Davies, Keytesville, Mo.—About twelve weeks, depending largely upon the growth of the pigs and the condition of the sow. I wean my pigs on cowpeas, milk, and a little corn.

Theo. Louis, Louisville, Wis.—We generally let the pigs wean themselves at one hundred to one hundred and twenty days.

A. H. Hendricks, Hazelgreen, Wis.—Ten to twelve weeks old. I shut up the sows; feed on dry oats and water. Let the pigs run at large and they will wean themselves in a few days.

O. R. Aney, Wilmot, S. Dak.—Spring litters at eight weeks and fall litters at ten.

G. E. Dyksterhuis, Granada, Colo.—I feed sows on dry feed from about the eighth or ninth week after farrowing (according to the thrift of the pigs) until they have gradually weaned the pigs in the most natural way without checking the growth of the pigs. I start to induce the pigs to eat at about the third week of age and increase their feed gradually. I avoid any check in the growth of the pigs as much as possible.

S. B. Wright, Santa Rosa, Cal.—Usually let the sows wean them, which generally occurs at eight to ten weeks old. The pigs eat well then and the sows are removed, the pigs remaining where they have been fed.

M. H. McCord, Bakersfield, Cal.—Anywhere between two and three months. I usually make an inclosure of panels to accommodate the number of pigs to be weaned and make an opening large enough for the pigs to get through. In the inclosure I place my troughs and begin feeding with shorts slop or cracked oats slop, and in a short time the pigs are well able to take care of themselves and never stop growing. When they begin to eat well I remove the mothers to another lot.

FEEDING THE PIGS.

Attention will now be given to the pigs that have been weaned. Up to this time all are on the same feed and under the same management. From now on, however, those that are to be retained as breeding animals should be continued on a growing ration—that is, one which is somewhat narrow and will develop bone and muscle to the largest extent; those that are to be fattened for market should be fed more liberally and their feed made more carbonaceous.

THE BREEDING STOCK.

The foundation on which to build up a successful breeding animal is ample range, affording an abundance of exercise, and a rather narrow ration. Growth should be continuous and feed plentiful. The pigs should not be given range so large and so little feed that they will develop nothing but bone; neither should they have so much to eat that they will become indolent and refuse to take the exercise required to develop necessary bone and muscle. Exercise will strengthen the sinews and develop strong muscles, as well as firm joints and strong legs, while a well-filled stomach will nourish these; and from this management we may expect a sow that will be strong, thrifty, and a good breeder, and a boar that will do good work in the herd without breaking down in any respect before he should.

Gilts should not be served before the age of 8 months, bringing the first litter at 12 months. This gives sufficient time for the development of the reproductive organs.

FATTENING.

As soon as it is determined what pigs are to be fed for market their fattening should be started without delay. Experiments have repeatedly proved that young animals always fatten more economically than old ones, and therefore any delay in finishing is accompanied with a loss. In rare instances it may pay to keep a pig over winter as a "store" hog; but generally he loses the flesh he accumulated while suckling his dam, and this can not be replaced except at increased expense. Corn will now come into the ration, and should be supplemented by all the variety of feed at the feeder's command, to keep the appetite keen and the digestive system in the best condition. This variety should consist of mill feeds, dairy by-products, and succulent feeds, and, according to some authorities, pasture. If skim milk, whey, and buttermilk are at command they can be combined to very good advantage with the ration, commencing with a proportion of about 2 pounds of milk to 1 of grain at weaning time, and reducing the quantity of milk until the pigs are finished on grain alone. A pig gives best returns from dairy by-products while young. The fattening pigs should gain from 1 pound to 1½ pounds daily, and should weigh between 250 and 300 pounds at 9 or 10 months of age. Gains made after this weight are nearly twice as expensive as those made when weighing from 50 to 100 pounds, and a well-bred pig finished at a weight of about 250 pounds will very nearly fill the market requirements and bring a satisfactory price.

SELECTION OF BREEDING STOCK.

The pigs which are to be used for breeding purposes should be selected during the time when the pigs are with the sow. If he is raising hogs for market a breeder will select only sows, castrating all boars. No boar should be used or sold that is not eligible to registry. If the breeder is raising purebred stock the inferior boars will be culled out and castrated, the others being kept for the breeding market.

The selections should be made as early as possible, depending on the skill of the breeder. That noted feeder, the late Mr. William Watson, used to select his show lambs and calves not later than three days of age. He said an animal had all the development of heart and rib at that age that he would ever get, and his results in the show ring bear out the accuracy of his judgment. However, all are not endowed with the keen insight into animal form that Watson possessed. A selection for a breeding animal should not be made unless there are good and sufficient reasons for it, and unless the breeder is quite sure he is right in making the selection. The sows selected should be from large litters and from dams that are good milkers, and of quiet, motherly dispositions.

CASTRATING AND SPAYING.

The boar pigs should be castrated during cool weather, as soon as the testicles descend into the scrotum. An early date is always preferable to a late one; for the development of sex characteristics is of no value to an animal that is intended for meat.

The practice of spaying sows is not very general. It is much more difficult than castration. It often happens that sows which have been impregnated before spaying bear good litters of pigs after that operation.

The age of castration mentioned by correspondents has been tabulated, and it is found that 341 breeders made definite statements, as follows:

At or over 1 week of age	5
At or over 2 weeks of age	40
At or over 3 weeks of age	1
At or over 4 weeks of age	57
At or over 6 weeks of age	66
At or over 8 weeks of age	64
At or over 9 weeks of age	2
At or over 10 weeks of age	26
At or over 12 weeks of age	80

MANAGEMENT OF THE DRY SOWS.

After the pigs are weaned the dry sows should be placed in a pasture by themselves and given very little grain. Those that show themselves to be prolific and good mothers should be retained as breeders; those having a deficient breeding record or being unsatisfactory in any way should be fattened and sold as soon as possible. It does not pay to keep over a year a sow that can not raise a large litter, unless she is purebred and a very exceptional individual.

If a second litter is wanted during a year the sows should be put to the boar during the first heat after weaning. Many breeders do not like to pass many periods of heat for fear that the sows may become "shy," and there is little reason why the sow should not have two litters a year. In any case, the sows should be carried on comparatively light feed until time to breed again, gaining a little in weight; and their treatment after breeding should be as already detailed (pp. 35–45).

MANAGEMENT OF THE BOAR.

The management of the boar has been left until this place in the discussion, not because it is an unimportant subject, but because the sows occupy by far the greatest amount of the breeder's attention; and also because it was assumed at the outset of this discussion that the work of a beginner, with only a group of brood sows, was being outlined.

When the boar arrives at the farm he should be dipped, as a matter of ordinary precaution, against the introduction of vermin. As an additional precaution, a quarantine pen should be ready for him, especially if epidemics are prevalent. In short, he should be treated in much the same manner as has been prescribed for the sows. His feed before change of owners should be known, and either adhered to or changed gradually to suit the new conditions. If he has come a long journey it will be well to feed lightly until he is well acclimated.

His permanent quarters should be a clean, dry, warm, well-lighted, and well-ventilated pen, 10 or 12 feet square, with a yard adjoining where sows may be brought for service. This yard should be large enough to give him some exercise during the breeding season, when it may be inconvenient to allow him the run of a pasture. Adjoining the yard should be the boar's pasture, from one-half acre to an acre in extent, consisting of clover, alfalfa, or good pasture grasses that thrive in the locality.

Breeders generally advocate the practice of keeping a boar to himself during the entire year—out of sight and hearing of the sows. However, a boar is often allowed to run with the sows after they are safe in pig; but during the breeding season it is by far the best policy to keep him by himself, admitting a sow to his yard for mating, and allowing but one service. This will be productive of the best results in many ways. The energies of the male are not overtaxed. He may thus serve a much larger number of sows, and the litters will generally be larger and the pigs stronger. In the case of a sow that is a somewhat shy breeder and a valuable animal, she may be allowed to remain with a boar during the greater part of her heat; but such instances are exceptional. Another advantage of the single-service system is that a man always has an accurate knowledge of his breeding operations and knows when to expect farrowing time.

The feed of the boar when not in service may be of a succulent nature—mainly pasture and cut green forage during the summer months and roots in winter. A boar can hardly be sustained on this alone, and some grain should be allowed to keep him in condition. This should be nitrogenous in character, consisting of mill feeds—such as shorts, middlings, and bran—some oil meal, and the leguminous grains, with a little corn. As the breeding season approaches, the feed should be increased, so that the boar will be in good condition. While not in service, ample exercise should always be insisted upon, even if it must be urged by the whip. Exercise is productive of well-developed muscles and general thrift; with these two conditions, activity and soundness of reproductive organs will usually follow. During the breeding season it will not be possible for the boar to get the same amount of exercise, and accordingly care must be taken that his energies are not wasted by unnecessary service. Careful feeding will do much to counteract this disadvantage. It must always be remembered that the drains on a boar during service are severe, especially if 50 or 60 sows are served. This will require ample feed, with as much exercise as possible, and, with care in his treatment, will bring about good results. A fully matured boar should not serve more than two sows daily, preferably one in the morning and one in the afternoon, and can serve 50 or 60 in a season without difficulty.

Coburn[a] advises that where farmers own but 12 or 15 sows each, three or four breeders might purchase a boar and use him in common, thus saving materially in expense. Cownie[b] states that he has found it well to have at least two boars in the herd, even though the herd be small in numbers.

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[a] Swine Husbandry, pp. 93, 94.

[b] Kansas State Board of Agriculture, Thirteenth Biennial Report, p. 693.

SANITATION IN THE HOG LOT.

The greatest drawback to the hog industry which breeders in this country have to contend against is the presence of highly contagious diseases known as hog cholera and swine plague, or, popularly, as "cholera," and were it not for the fecundity of these animals their profitable production would be out of the question. These two diseases are so closely identical that post-mortem examinations are usually required to distinguish between them. Indeed, only recently (on October 1, 1903) De Schweinitz and Dorset, of the Bureau of Animal Industry, announced the discovery of a fatal disease of hogs which is caused neither by the hog-cholera nor swine-plague bacilli, and which is apparently a very frequent cause of swine fatalities.

For the present the breeder can regard these diseases as identical, so far as his practical management of the herd is concerned.

There are a few fundamental facts which he must remember if he is to avoid losses by reason of the presence of hog cholera or swine plague in the herd. The first is that they are specific germ diseases, disseminated by bacteria, and the contagion can not be spread from one animal to another or from one herd to another except by these minute organisms. They may be carried in a multitude of ways—by the hogs themselves, on the clothing of persons, on vehicles, in feed, by dogs, birds, and other animals, or by streams. The breeding or feed of a hog can not cause either disease, although bad methods may so weaken constitution and vitality that the animal becomes more susceptible than would otherwise be the case; second, diseases caused by bacteria may be prevented in large part by thorough disinfection; third, bacteria are generally preserved in filth, and, therefore, scrupulous cleanliness will go far toward preventing outbreaks of disease in herds of hogs.

PREVENTION OF DISEASE.

Cleanliness.—Preventive measures must be most relied upon. Hogs must be given dry and well-ventilated quarters, which must be kept clean. Contrary to common belief, hogs have some habits which raise them above other domestic animals from the standpoint of cleanliness. For example, unless compelled to do so, a hog will not sleep in its own filth. If part of the floor of the pen is raised and kept well bedded with straw, while the rest is not, all excrement will be left on the unbedded portion of the floor, and the bed itself will always be clean. Feeding and drinking places should be clean and the water supply pure. Unless the origin is known to be uncontaminated and there has been no possibility of infection during the course, hogs should not be allowed access to streams. Wallows should be kept filled up as much as possible. At least once a month the quarters should be disinfected with air-slaked lime or a 5 per cent solution of crude carbolic acid. If a hog dies from any cause, the carcass should be burned or buried and the pens thoroughly disinfected at once.

Breeding and feeding.—While inbreeding is the surest and quickest means to fix type, the system weakens vitality unless very carefully followed. For this reason closely inbred hogs are more susceptible to cholera than those whose constitutions have not been impaired by the system. The straight corn diet which many hogs receive from one year's end to the other also lessens vitality, and the researches of the Wisconsin Experiment Station have shown that this is probably brought about by actually retarding the development of the vital organs. A minimum of inbreeding and a varied diet, including, especially for breeding stock, ample range, will therefore better enable the herd to resist the attacks of disease.

Isolated houses.—The advantage of a number of small, portable houses, each accommodating a few hogs, rather than one large piggery for the entire herd, has been referred to in the foregoing pages. In districts where cholera is prevalent these are undoubtedly the best shelters. They make it more difficult to carry contagion to all animals in the herd, and the destruction of one of them in case of an outbreak does not entail a great expense. An added advantage is that they may be moved from place to place as needed. While more work is necessary in feeding, the convenience and safety from their use more than offsets this disadvantage.

Quarantine.—Whenever new animals are brought to the farm, or when animals are brought home from shows or from neighboring herds, they should be kept apart from the rest of the herd for at least three weeks. If they have been exposed, the disease will manifest itself within this time, and the sick animals can be treated or killed and disposed of at once.

If cholera breaks out in the neighborhood the farmer should maintain a strict quarantine against the infected herds. He should refrain from visits to farms where they are located and should insist on his neighbors staying out of his hog lots. Intercourse of all kinds at this time should be carefully restricted. The contagion is so easily carried that the strictest measures are justifiable.

TREATMENT OF DISEASES.

As soon as sickness appears in the herd the unaffected hogs should be at once removed to clean, disinfected quarters, preferably without much range; for by running over pastures they may come in contact with contagion. Their feed should be carefully regulated and, if they have previously been on pasture, should include some green feed, roots, or an abundance of skim milk.

The quarters in which the sickness first appeared should be thoroughly cleaned, all bedding and rubbish burned, and loose boards and old partitions torn out and burned. If the pen is old, knock it to pieces and burn it. Disinfect pens and sleeping places, using air-slaked lime on the floors and the carbolic-acid solution on the walls and ceilings. Whitewash everything. If a hog dies burn the carcass or bury it deeply out of the reach of crows, buzzards, or dogs. If possible, do not move the carcass from the place where it falls; but if this can not be done the ground over which it is dragged should be disinfected. Hog cholera bacilli can live in the ground for at least three months. Care must be taken to maintain an absolute quarantine between the sick and well hogs. The same attendant should not care for both lots unless he disinfects himself thoroughly after each visit to the infected hogs. Dogs should be confined until the disease is stamped out.

Treatment of hogs suffering from cholera or swine plague is not always satisfactory. The disease runs its course so rapidly that curative measures are more or less ineffectual, and prevention of an outbreak should be relied upon rather than the cure of sick animals. Dr. Salmon[a] states that the following formula has been successful in less virulent outbreaks when properly administered as soon as signs of sickness are shown:

	Pounds.
Wood charcoal	1
Sulphur	1
Sodium chlorid	2
Sodium bicarbonate	2
Sodium hyposulphite	2
Sodium sulphate	1
Antimony sulphid (black antimony)	1

"These ingredients should be completely pulverized and thoroughly mixed. In case there is profuse diarrhea the sulphate of sodium may be omitted."[a]

A large tablespoonful once a day for each 200 pounds of live weight of hogs to be treated is a dose. The medicine should be thoroughly mixed with the feed, which should be soft, made of bran and middlings, corn meal and middlings, corn meal and ground and sifted oats, or crushed wheat, mixed with hot water. It the hogs are too sick to come to the feed, they should be drenched by pulling the cheek away from the teeth and pouring the medicine in slowly. Care should be exercised, as hogs are easily suffocated by drenching. Do not turn a hog on its back to drench it.[a]

PREVENTION AND DESTRUCTION OF VERMIN.

Hogs often suffer very much from vermin. Lice are introduced from neighboring herds, and the losses in feeding are often severe, especially among young pigs, when death is sometimes a secondary if not an immediate result. When very numerous, lice are a very serious drain on vitality, fattening is prevented, and in case of exposure to disease the lousy hogs are much more liable to contract and succumb to it.

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[a] Farmers' Bul. No. 24, U. S. Dept. Agr.

Vermin are most common around the ears, inside the legs, and in the folds of the skin on the jowl, sides, and flanks. In light and isolated cases they may be destroyed by washing the hogs. In severe cases, however, especially where the whole herd is affected, thorough spraying or dipping should be resorted to. In this case a dipping tank will be a great convenience.

One of the most effective and cheapest preparations to use as a dip is a 2 per cent solution of creolin. The common tobacco dips used for sheep scab are also efficacious. If the hogs are washed, apply the solution with a broom; if they are sprayed, use an ordinary spray pump; for dipping, use a dipping tank. When being washed or sprayed the hogs should stand on a tight board floor.

Newly purchased hogs should be carefully examined for vermin, and they should not be turned with the herd until they are known to be free from these pests.

When the herd is found to be badly infested with lice, all bedding should be burned and loose floors and partitions torn out. Old boards and rubbish should be burned. The quarters should then be thoroughly disinfected by spraying with one of the solutions mentioned. (The creolin solution is good.) After disinfection, as in the case of a disease outbreak, everything about the place, inside and out, should be thoroughly whitewashed.

In these remarks on sanitation no attempt has been made to go into the details of the diseases affecting hogs or their treatment. They are simply intended to call attention to the simple measures which may be used by any farmer to avoid, to a large extent, the decimation of his herd by epidemics. Cleanliness and rational methods of management are relied upon by thousands of farmers to keep their herds in health and vigor. They are the marks of the good farmer and successful hog breeder.

RECENT AMERICAN EXPERIMENTAL WORK.

RECENT EXPERIMENTAL WORK IN PORK PRODUCTION.

INTRODUCTION.

In presenting the following review of experimental work, no attempt is made to give a complete compilation of all the work that has been done in pork production; a résumé of this work would be simply a repetition of what has previously been accomplished in a more thorough manner by others. During recent years, however, the experiment stations have paid a very large amount of attention to this phase of animal husbandry, some of which has the highest value to the producer; and this work has not been compiled heretofore.

In this bulletin complete reviews are given of those experiments only where methods or results are in dispute (such as the relative value of feeding grain whole or ground), or where a practically new feed is being used, to note its effects (such as cotton-seed meal, which heretofore has been regarded as out of the question as a hog feed). Information on grain fed whole or ground and on the feeding of cotton-seed meal is always in order, and their importance, both to the farmer and to the experimentalist, is such that a view of the entire field is necessary to a proper and intelligent discussion of the subject. Where a method has become practically obsolete in hog feeding—such, for example, as cooking—very little recent study has been done by experiment stations.

In studying the results of experimental work it is important to bear in mind that different conditions influence strongly the work of different stations. At the conference of animal husbandry workers in Chicago during the International Live Stock Exposition of 1902, Prof. W. A. Henry called attention to this fact. He pointed out that an "average," to be of any scientific value, should summarize work conducted with all conditions—such as age of animals, breeding, kinds of feed, care, management, and season of the year—as uniform as possible, and should represent the results of the labor of one man conducted at the same station and extending over a very considerable term of years. These factors are all of the highest importance and it is essential that they be considered in studying results. Good feeders know that animals of different ages feed differently, that breed is often an influential factor, that all feeds do not have the same value in the ration, and that good shelter and regular and skillful feeding are highly essential to secure profitable results. It is also readily apparent that, if all other conditions are equal, an experiment conducted in Maine to compare the value of corn meal with that of whole shelled corn can not be averaged, but only compared, with one of a similar nature conducted in Iowa or Oregon; the factor of climate is important and influential. The results of an experiment with hogs fed in the summer months are not to be averaged with those obtained with similar animals under exactly similar conditions of feed, care, and management during the winter. Even where all conditions are similar and every care has been taken to make them as uniform as possible, seasonal variations of climate may inject another factor of error. The results of two experiments conducted by a corn-belt station, the one during 1901, the other in 1902, could not be averaged with propriety, although they were conducted as uniformly as possible, because the year of 1901 in the central west was one of drought and the summer exceptionally long and hot; whereas weather conditions were exactly the reverse during 1902, when an unusual amount of rainfall was recorded, with very low temperatures during the summer.

Again, though not so frequently recognized, the personality of the experimentalist has a great deal to do with the value of his work. It is unfortunate that frequently a man is placed in a position to conduct experimental work whose qualifications for it are not of the highest order. Results from his work are not so valuable as those from men who combine a large fund of scientific information with an intimate knowledge of the practical care and management of the animals fed.

If the farmer will bear in mind the influence of these modifying conditions, he can better realize the difficulties that surround experimental feeding; he will better understand their value, and will find himself listening more carefully to the advice of experiment station workers, reading bulletins with more confidence, and condemning less hastily what seems to be inaccurate. If each farmer regarded himself, in a way, as an experimentalist and should spend a small amount of time in keeping records of his operations, studying the results with the aid of the information at his command, and if he should at the same time keep in touch with the authorities of his experiment station, there is little doubt that many of the problems now perplexing farmers would be brought much nearer to a solution and the business of feeding live stock rendered more systematic and profitable.

While much may be said against averages, it is a fact that, unless the conditions vary greatly and the extremes are too divergent, a general idea is conveyed by an average that has a practical utility, in that it shows the general results that may be expected to follow certain practices. The averages shown in these pages should be regarded in this light.

As a general rule, the figures given in the following pages relating to experimental work are taken from the station bulletins exactly as they appear in those publications. In some cases obvious typographical errors have been corrected.

PRINCIPLES OF FEEDING.

PHYSICAL CHARACTER OF FEEDS.

Feeds, as regards their physical characteristics, are generally divided into two classes, namely, concentrated feeds, or concentrates, and bulky feeds, commonly called coarse fodder, roughage, or forage. The seeds of plants, whole or ground, and all such feeds as are produced from the by-products of commercial establishments (mills, packing houses, etc.), supply a large amount of nutriment in small bulk, and hence are called concentrates. The body of plants, in the form of hay of all kinds, straw, green fodder, pasture grasses, and roots and tubers, gives us bulky feed or roughage. Vegetables, such as pumpkins, and the waste fruit of orchards are often fed to animals and are in the category of bulky feeds. All of these supply a relatively small amount of nutriment and a large amount of feed material. Milk is, properly speaking, a bulky feed when fed to rather mature animals, particularly when skimmed. For young animals whole milk is the most "complete" feed known, but it is too expensive to feed any but the youngest animals, or those that are to be brought to the highest condition in the shortest possible time.

RELATION OF BULKY FEED TO LENGTH OF ALIMENTARY CANAL.

The amount of bulky feed required is different with different species of animals and depends upon the complexity of the feed of the animal; and the kind and variety of feed in turn have a direct relation to the length and complexity of the alimentary canal. For example, in a state of nature carnivorous animals, such as those of the cat and wolf tribe, have very short and simple alimentary canals, and live upon flesh, which is a very simple diet. Herbivorous animals—that is, those that subsist exclusively upon grasses, browse, etc., such as the horse, ox, sheep, and goat—have the most complicated digestive apparatus and eat a very great variety of feeds. Between these two classes we have those animals that live both on a flesh and a vegetable diet, and with them the alimentary canal is longer and more complicated than that of the carnivora, but shorter and less complicated than that of the herbivora. The pig belongs to this class, which is denominated the omnivora. Domestication has changed the habits of animals considerably, and in so doing has changed the internal characteristics of the body. Domestic dogs and cats have been brought to subsist on a diet in which there is a rather large amount of vegetable matter. Pigs are fed almost exclusively on a vegetable diet and only occasionally indulge their appetite for an animal diet. As a consequence of this variation in the range of feed eaten in domestication, these animals have a longer and more complicated digestive tract than the same species in the wild state.

FUNCTION OF BULK IN THE FEED.

The function of bulk in the feed is more than the mere furnishing of nutriment; for, in a mechanical way, it aids digestion. In the ruminant animals especially there is an enormous stomach content which must be comfortably filled if digestion is to be carried on properly. Hence, with this class of animals a great amount of hay, etc., is required, and they can also give the best returns from a bulky feed and subsist more satisfactorily than any others on hay or straw alone. Pigs require less bulky feed than other domestic animals, but recent experiments show that, to a certain extent, hay feeding is very valuable in pork production. Where herbivorous animals have been maintained for an extended period on feed which was exclusively of a concentrated nature, derangement of digestion has resulted.

CHEMICAL COMPOSITION.

From a chemical standpoint, the constituents of feeds that most immediately concern the feeder are the nitrogenous substances, generally termed protein compounds, which contain a large percentage of nitrogen; the starches, sugars, etc., called carbonaceous substances or carbohydrates, from the fact that they are composed of carbon, with hydrogen and oxygen in the proportions in which they occur in water (they are termed "nitrogen-free extract" in chemical analysis), and fat, found in analysis under the heading of "ether extract." Ash is also of importance and often should be more carefully considered when feeders are making up their rations.

WATER CONTENT.

The most valuable portion of feeds is the water-free substance, or dry matter, of the feed. This is what remains of a feed after heating it in a drying chamber at or near the boiling point until repeated weighings show no change in weight. The amount of water present in feed is obviously an important factor. While water yields neither tissue-building material nor energy, it enters into the composition of the body and is indispensable. When animals are compelled to take into the system water beyond the normal amount, undesirable results will follow. When animals are fed exclusively on roots or skim milk they do not receive more than enough to maintain bodily functions. This is readily understood when we consider that roots contain about 90 per cent and skim milk about 88 per cent of water. On the other hand, hay does not ordinarily contain more than 15 to 20 per cent of water, while grains, leguminous seeds, and milling products contain only about 10 per cent. The water content of feed is very much influenced by weather conditions, especially in the case of roughage, which absorbs large amounts of moisture in wet weather.

ENERGY.

A factor that is being more carefully considered in studying the value of a feed, or a ration, is the amount of energy which it will yield. When feed is utilized in the animal body a certain amount of heat is evolved, the process not being unlike the consumption of fuel in a furnace. This heat is converted into the energy which is necessary whenever work is performed. It is apparent, then, that a horse at hard work will need a ration that will supply more energy than one at moderate or light work. The term work, however, has a wider significance than denoting actual muscular effort in the performance of a task. The operations of mastication, deglutition, and the contraction of the walls of the stomach and intestines involve muscular action, both voluntary and involuntary; in the movements of the heart and lungs and the circulation of the fluids of the body, muscular action of some kind is constantly going on; in fact, the performance of nearly every function of the body is actually some form of work involving the expenditure of energy, accompanied by the evolution of heat and maintained by the energy-yielding material in the feed. The amount of work performed by an animal in the ordinary processes of "hustling for a living"—that is, finding its feed, eating it, and digesting it—is enormous. In experiments, reviewed in the following pages, with suckling pigs, Miss Wilson[a] found that the young animals required nearly as much energy per square meter of surface as had been found by other investigators to be required by a man at hard work. It is therefore readily apparent that the heat-producing powers of feed have a very much more important function than the maintenance of bodily warmth. The unit of energy used in computing the value of a feed from this standpoint is the "small" calorie, which is the amount of heat necessary to raise 1 gram of water 1° C.

Fats yield a greater amount of energy than either the carbohydrates or protein, there being very little less energy given up by proteids when digested than by carbohydrates.

RELATION OF FEED TO THE ANIMAL BODY.

We have seen that the most important constituents of feed are the proteids, the carbohydrates, and the fats. These are practically all that the feeder considers in making up his rations, although the physiologist must consider other compounds which exist in smaller quantities. In the body we find, in the water-free matter, the proteids, the fat, and the ash.

The following table shows graphically the relation between the constituents of the feed and those of the body—that is, the disposition of the feed:

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[a] See pp. 232–236.

Disposition of feed in the body.

Feed.	Body.
Water	Water.
Proteids	Proteids.
Carbohydrates	Fat.
Fat	
Proteids (rarely)	
Ash	Ash.
Fat	Energy.
Carbohydrates	
Proteids	

It is seen that the water of the feed reappears as the water in the body. The proteids in the feed form the proteids in the body. The fat of the body is formed from the carbohydrates and fat of the feed and occasionally from the proteids. The ash of the body, such as the mineral matter of the bones, comes from the ash of the feed. The three principal feed constituents—fat, carbohydrates, and protein—yield energy in the order named, fat yielding the most energy for an equal weight of feed. The carbohydrates and proteids are practically equal in heat-yielding power.

Now, as different animals have different demands made upon them, we must expect them to require these constituents of feed in different proportions. To be more explicit, a young and growing animal is building up tissue rapidly, and this should be largely muscular and bony if the best health is maintained. Muscular tissue is largely made up of proteids, and we therefore expect a large amount of protein matter in the feed. There should also be a plentiful supply of mineral matter and phosphates so that the skeleton may be properly built up. As milk is rich in nitrogenous material, we find it an excellent feed for growing animals. Again, animals that are to be fattened rapidly must have a large amount of fat-producing material in the ration, for which reason farmers find corn such a valuable feed for this purpose. Horses that are at hard work require a ration that will give an ample supply of energy. The large amount of energy yielded by fattening rations and heavy-working rations has an interesting bearing on the shelter requirements. Steers that are on full feed can enjoy themselves in the coldest weather if provided with a simple shed that will protect them from cold winds, rain, and snow, and human beings readily recognize the fact that where a large amount of exercise is indulged in, with ample food, a much greater amount of cold may be endured than where no exercise is taken and the ration is light.

DIGESTIBILITY OF FEED.

The amount of nutritive material which an animal can get from his feed is a very important factor. It is obvious that when skim milk or roots are fed alone immense quantities must be eaten to give a sufficient amount of nutritive material. A similar condition is met with when feeds having a low digestibility are given. For instance, when animals are wintered at straw stacks they acquire large stomachs by reason of gorging themselves with coarse, bulky feed, and generally have a half-starved appearance because they are not able to obtain from such feed an adequate amount of nourishment to maintain flesh and condition. Hay and straw contain large amounts of crude fiber, which is composed of carbohydrate material, largely cellulose, and which is only partially digestible. The crude fiber in grains is insignificant, except in the hulls, and hence their higher digestibility.

THE NUTRITIVE RATIO.

In discussing feeding, the term "nutritive ratio" is frequently met. This means simply the ratio between the total amount of digestible protein in a ration (that is, one day's feed) to the total amount of digestible carbohydrates plus 2.25 times the digestible fat. The fat is of greater value for the purpose of yielding energy than the carbohydrates, and chemists have determined that this ratio is about 2.25; hence the reason for this factor in the computation of a ration. As the functions of the fat and the carbohydrates are very similar, the reason is apparent for the addition of the former. There are many publications available that discuss in detail the computation of rations. One of the principal things to avoid is getting a ration which, while correct, so far as nutritive ratio is concerned, can not be fed successfully on account of its low digestibility or high water content.

PREPARATION OF FEED AND METHODS OF FEEDING.

Investigation of the value of different methods of preparing feed was one of the earliest efforts of the experiment stations made in animal husbandry. The questions that relate to this subject were at once recognized to be of the highest importance and their study very interesting. The subject divides itself into three general sections: (1) Cooking, (2) grinding, and (3) wetting, or soaking.

COOKING.

The utility of cooking feed for animals, and especially for pigs, was given most attention in the days previous to investigations by experiment stations. The subject demands only brief consideration here. Cooking feed is no longer regarded as an economical practice for fattening animals. However, for breeding stock and sick animals, and for animals which it is desired to put into the very highest condition, cooking may be practiced with good results, if expense is disregarded. Pigs so fed show marked thriftiness and health.

GRINDING.

The question whether grain should be fed whole or ground is by no means settled; thus it is one that differs radically from that of cooking, and is of much more importance to feeders.

THE PHILOSOPHY OF GRINDING GRAIN.

The theory of grinding grain is that when the feed is in the condition of a meal it is more readily or quickly available for digestion. It is fallacious to claim that a feed given as meal contains more digestible matter than the same feed before it has been reduced to the condition of meal; for that is a thing that is obviously impossible. But it is not, perhaps, incorrect to say that the digestive fluids may be more effective in their action on feed that has been crushed or ground, and that less undigested matter is voided by the animal than when whole grain is given. The amount of the feed that is absorbed (digested) in its passage through the body, plus the undigested nutrient content of the excrement, practically equals the total digestible matter in the feed before eaten. All practical feeders readily recognize the great possibility of loss by way of the excrement when feeding steers on shelled or ear corn, and, to obviate this, they use hogs to consume the waste. Some waste is inevitable. There can not be perfect feeds or perfect digestions; but we may avoid wasteful methods, and the feeder's problem is to render the loss of feed in the manure as small as possible. It is unnecessary to remark that grain which is swallowed without being masticated is much more likely to pass undigested than if thoroughly masticated before swallowing. The kind of grain that is more readily masticated when fed whole would therefore seem to be less in need of grinding than that which is more generally swallowed without thorough mastication.

EXPERIMENTS TO DETERMINE THE AMOUNT OF UNDIGESTED GRAIN.

The Central Experimental Farm,[a] at Ottawa, Canada, conducted experiments to study this subject with pigs. Whole grain was fed and the excrement was collected for one day, the whole grain in it washed and weighed, the weight per bushel estimated, and the germinating power determined. The following table shows the results:

Loss in feeding whole grain.

Ration.	Amount consumed.	Amount unmasticated.		Estimated weight per bushel.	Germinating power.
	Lbs.	*Lbs.*	*Oz.*	*Lbs.*	*Per cent.*
Oats, soaked 54 hours, all pigs would eat clean, and 3 pounds skimmed milk per head daily	14	2	6	22¼	11
Barley, supplemented as above	17	2	2	35	0
Pease, supplemented as above	17		2	(a)	0
Indian corn, supplemented as above	11		8	40¼	8

a Amount too small to estimate.

The results of this experiment are very interesting. Note that the amount of grain passed whole is influenced by the size and kind of the grain; for example, oats and barley were passed in much larger amounts than pease or corn. However, there was practically no difference in the percentage of loss in weight, and the germinating power of the excreted grains does not seem to have depended on their size. It is interesting to compare these results with the tables in the following pages, which show the results of the experiment station work with grinding grain.

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[a] Bul. No. 33.

EXPERIMENTS WITH GROUND AND UNGROUND GRAIN.

Ground compared with whole corn.—Numerous stations have reported experiments with ground corn compared with whole shelled corn. There is a considerable amount of variation between them, the results in some cases showing as great a loss from grinding as is gained in others. The following table shows results that have been obtained at experiment stations in various parts of the country. Where corn was fed on the cob the amount is reduced to equivalent weights of shelled corn or not included in the averages:

Results of experiments with ground and unground corn.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Whole grain.	Meal.	Milk.	Whole grain.	Meal.	Milk.
Alabama: [a]		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	2	78	55	21	1.31	-------	182	-------	-----	330	-----
Whole corn	2	80	28	21	.66	155	-------	-------	536	-----	-----
Corn meal	2	172	67	21	1.59	-------	216	-------	-----	323	-----
Whole corn	2	104	36	21	.85	138	-------	-------	384	-----	-----
Maine: [b]											
Corn meal	3	86	385	196	.65	-------	-------	-------	-----	-----	-----
Whole corn	3	86	387	196	.66	-------	-------	-------	-----	-----	-----
Corn meal	3	165	252	84	1.00	-------	-------	-------	-----	-----	-----
Whole corn	3	165	271	84	1.08	-------	-------	-------	-----	-----	-----
New York State: [c]											
Corn Meal	4	110	253	63	1.00	-------	-------	-------	-----	269	-----
Corn on cob	4	112	174	63	.69	-------	-------	-------	401	-----	-----
Ohio: [d]											
Corn meal, cooked	3	191	404	112	1.20	-------	2,386	-------	-----	590	-----
Corn on cob, cooked	3	202	167	112	.50	2,109	-------	-------	1,260	-----	-----
Corn meal	3	205	383	112	1.14	-------	2,116	-------	-----	552	-----
Whole corn	3	199	404	112	1.20	2,039	-------	-------	505	-----	-----

[a] Bul. No. 8, Canebrake Sta.

[b] An. Rpts., 1887 and 1888. The rations in the first experiment included raw potatoes and skim milk. Those pigs in the second were fed corn meal and water and corn and water.

[c] An. Rpt., 1898. A supplementary ration to give variety was fed both lots. The "feed per 100 pounds gain" is dry matter.

[d] Sixth An. Rpt. The weights of the feed eaten by the lots fed whole corn in these experiments represented equivalent amounts in shelled corn, the weight of the ear corn being thus reduced to show the actual amount eaten.

Results of experiments with ground and unground corn—Continued.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Whole grain.	Meal.	Milk.	Whole grain.	Meal.	Milk.
West Virginia: [a]		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	6	195	361	28	2.15	......	1,699	......	......	471	......
Whole corn	3	239	141	28	1.68	819	......	......	579	......	......
Corn meal	6	95	581	56	1.73	......	2,384	......	......	410	......
Whole shelled corn, soaked	6	95	555	56	1.65	2,138	......	......	385	......	......
Kentucky: [b]											
Corn meal	2	100	175	63	1.39	......	753	......	......	430	......
Whole corn	2	100	182	63	1.44	780	......	......	429	......	......
Corn meal	3	149	113	28	1.35	......	286	......	......	253	......
Whole corn	3	196	65	21	1.03	357	......	......	549	......	......
Missouri: [c]											
Corn meal	4	160	638	78	2.04	......	3,196	......	......	501	......
Whole corn	4	150	594	78	1.90	2,864	......	......	482	......	......
Corn meal	4	85	250	116	.54	......	1,612	......	......	645	......
Whole corn	4	86	164	116	.35	1,239	......	......	755	......	......
Wisconsin: [d]											
Corn meal	10	255	528	30	1.76	......	2,004	1,002	......	380	190
Whole corn	10	251	420	30	1.40	1,815	......	908	432	......	216
Corn meal	9	346	1,348	70	2.13	......	5,968	......	......	443	......
Whole corn	9	354	1,235	70	1.96	5,947	......	......	481	......	......
Corn meal	10	223	1,076	70	1.53	......	5,236	......	......	487	......
Whole corn	10	225	789	70	1.12	4,665	......	......	591	......	......
Corn meal	9	210	1,348	84	1.79	......	5,956	......	......	442	......
Whole corn	9	212	984	84	1.30	4,926	......	......	501	......	......
Corn meal	7	198	576	63	1.30	......	2,660	......	......	462	......
Whole corn	7	183	552	63	1.25	2,340	......	......	424	......	......
Corn meal	8	187	992	84	1.47	......	4,698	......	......	473	......
Whole corn	8	184	830	84	1.23	4,137	......	......	500	......	......
Corn meal	8	184	1,030	84	1.53	......	4,617	......	......	448	......
Whole corn	8	184	799	84	1.19	3,914	......	......	489	......	......
Corn meal	19	186	2,132	84	1.34	......	10,794	......	......	507	......
Whole corn	19	186	2,136	84	1.34	10,626	......	......	497	......	......
Corn meal	14	175	1,938	98	1.41	......	9,275	......	......	479	......
Whole corn	14	174	1,571	98	1.15	8,778	......	......	559	......	......
Corn meal	12	148	1,038	84	1.03	......	5,745	......	......	553	......
Whole corn	12	145	893	84	.89	5,256	......	......	588	......	......
Corn meal	3	72	218	84	.89	......	979	......	......	449	......
Whole corn	3	70	234	84	.93	1,038	......	......	444	......	......
Corn meal	3	80	166	84	.66	......	961	......	......	579	......
Whole corn	3	80	169	84	.67	1,004	......	......	594	......	......
Corn meal	3	134	274	91	1.00	......	1,407	......	......	513	......
Whole corn	3	133	255	91	.93	1,426	......	......	559	......	......
Average of 19 trials (where total feed is reported) with 297 pigs									524	479	......

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[a] Bul. No. 59.

[b] Bul. No. 19.

[c] Buls. Nos. 1 and 10, Agricultural College.

[d] Fifth and Thirteenth to Nineteenth An. Rpts. In all but the first test meal, such as shorts or middlings, was fed to give variety to the ration and give a good appetite and steady gains. It was in the same proportion to both lots in each test.

The results detailed above show a preponderating amount of evidence in favor of corn meal, judging purely from the basis of feed required for 100 pounds of gain and disregarding the expense of grinding. The average for 19 trials, with 297 pigs, where the amount of feed eaten is reported is 524 pounds of grain required per 100 pounds of gain when corn is fed whole in the form of shelled corn, and 479 pounds when fed ground, a difference of nearly 8.59 per cent in favor of grinding. This is considerably higher than the value usually given for corn meal, and may be explained to some extent by the large amount of feed required to make a given amount of gain in some of the experiments, notably the first at the Ohio Station, which must have been due to extraordinary conditions. Careful researches show that an exact estimate can not yet be made of the comparative value of shelled corn and corn meal. It is worthy of particular attention, however, that in these experiments there were only nine instances out of twenty-six where the value of the two feeds was equal or in favor of whole grain, and in one of the latter, the first Missouri test; although the gains are considerably in favor of the pigs on corn meal, they were more economically made by the pigs on whole corn. The instances that favor whole grain are the Maine experiments, the first in Ohio, the second in West Virginia, the first in Kentucky, the first in Missouri, and the fifth, eighth, and eleventh in Wisconsin.

The researches of Henry in Wisconsin have been the most exhaustive that have been undertaken on this subject. In the Nineteenth Annual Report of the Wisconsin Station he publishes the following summary of seven years' winter feeding "to determine the relative merits of ground and unground corn for fattening hogs." There were 210 hogs fed in all:

Utility of ground grain.

Year.	Number of pigs in each lot.	Average weight at beginning.	Condition at beginning.	Saved or lost.
		Pounds.		
1896	9	350	Thin	8 per cent saved by grinding.
	10	224	Fat	17.6 per cent saved by grinding.
1897	9	211	Rather fat	11 per cent saved by grinding.
	7	190	do	9 per cent lost by grinding.
1898	8	185	do	5.4 per cent saved by grinding.
	8	184	do	8.4 per cent saved by grinding.
1899	19	186	do	2 per cent lost by grinding.
1900	14	175	do	15 per cent saved by grinding.
1901	12	146	do	6 per cent saved by grinding.
1902	6	71	Fair	1 per cent lost by grinding.
	6	80	do	3 per cent saved by grinding.
	6	133	Rather fat	8 per cent saved by grinding.

In these experiments no allowance was made for cost of grinding. In nine cases grinding showed a saving of feed, the highest being 17.6 per cent and the lowest 3 per cent. In the three cases where there was a loss it was 9 per cent, 2 per cent, and 1 per cent, respectively.

Two experiments that have a very close bearing on this subject, but are not included in the above table, are reported from the New Hampshire and Colorado stations.

In New Hampshire Burkett[a] compared the feeding values of corn in ear with that of corn-and-cob meal. The lot receiving whole corn gained an average of 0.81 pound per day, at a cost of 333 pounds grain and 892 pounds skim milk per 100 pounds of gain. The meal-fed lot averaged 0.87 pound daily gain, at a cost of 319 pounds of grain and 855 pounds of skim milk per 100 pounds gain, a difference of 4 per cent in favor of grinding. The Colorado Station[b] made six tests with pigs averaging 62 and 63 pounds to compare ground and whole corn. Those on ground corn made an average daily gain of 0.52 pound, consuming 580 pounds of grain and 90 quarts of skim milk for each 100 pounds of gain. The pigs on whole corn made an average daily gain of 0.44 pound, consuming 670 pounds of grain and 120 quarts of milk for each 100 pounds of gain.

The only definite conclusion that can be drawn from these figures is that it is beyond anyone to say that an advantage may be expected to follow the feeding of corn meal sufficient to pay the cost of grinding. If corn sells on the open market at 50 cents per bushel of 56 pounds and grinding costs from 3 to 5 cents per bushel, a saving of 10 per cent by such methods would be very good economy; but if corn falls to 25 cents the cost of grinding must be lessened to make meal feeding profitable.

Pease.—An experiment with pease is reported from the Central Experimental Farm of Canada,[c] the results of which follow:

Ground compared with whole pease.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
							Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Ground, soaked 54 hours	4	62	224	162	126	1.28	276	468
Whole, soaked 54 hours	4	100	207	107	84	1.27	333	235

This experiment does not show any difference in the feeding value of ground pease as compared with whole pease, so far as daily gains are concerned, but the pigs on ground pease required 17 per cent less grain than those on whole pease. The results with both feeds were satisfactory.

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[a] Bul. No. 66.

[b] Bul. No. 40.

[c] Bul. No. 33.

Grinding small grain.—The amount of material available on the subject of grinding small grain is not so voluminous as that pertaining to corn. In the United States a great amount of the oats, wheat, barley, or rye fed is in the form of mill products and is, of course, ground. These feeds are, moreover, generally used as supplements to corn, and the greater attention has been directed to methods of corn feeding on this account. In common practice, perhaps, these grains are ground more generally than corn, as they are usually much harder. Their greater liability to pass through the animal undigested shows the correctness of such practice.

The following table shows results obtained at five experiment stations, comprising ten tests in all, with a total of 69 pigs:

Effect of feeding ground small grain.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.			Cost per 100 pounds gain.	
						Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.
Wisconsin:[a]		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Ground oats ⅓, corn meal ⅔	3		457	120	1.27		1,839			403			
Ground oats ⅔, corn meal ⅓	3		371	120	1.03		1,593			429			
Whole oats ⅓, corn meal ⅔	3		296	120	.82	1,457			492				
Whole oats ⅔, corn meal ⅓	3		246	120	.68	1,388			564				
Oregon:[b]													
Chopped oats and wheat	2	151	331	119	1.39		1,603			484			5.90
Whole oats and wheat	2	158	308	119	1.29	1,830			594			7.20	
Utah:[c]													
Chopped wheat, dry	2	126	330	135	1.22		1,421			431			
Whole wheat, dry	2	148	332	135	1.23	1,474			444				
Ontario Agricultural College:[d]													
Ground pease and barley (1:1)	3	107	390	91	1.43		1,589			407			3.87
Whole pease and barley (1:1)	3	109	333	91	1.22	1,589			477			4.25	

[a] Sixth An. Rpt.

[b] Bul. No. 20. In this experiment the pigs were fed on oats alone for two months, and the experiment was concluded with wheat alone.

[c] Bul. No. 70.

[d] An. Rpt., 1891.

Effect of feeding ground small grain—Continued.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.			Cost per 100 pounds gain.	
						Whole grain.	Meal.	Skim milk	Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.
Ottawa:[a]		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Pease, barley, and rye, ground, soaked 12 hours	5	69	104	119	.87	......	455	......	......	436	......	......	......
Pease, barley, and rye, ground, soaked 12 hours	4	76	134	119	1.12	......	464	645	......	346	481	......	......
Pease, barley, and rye, whole, soaked 48 hours	5	69	87	119	.73	386	......	......	445	......	......	......	......
Pease, barley, and rye, whole, soaked 48 hours	5	69	135	119	1.13	330	......	1,869	246	......	1,382	......	......
Oats, pease, barley, and ¼ part bran, ground, dry	4	69	126	119	1.06	......	450	......	......	356	......	......	......
Oats, pease, and barley, whole, dry	4	67	108	119	.90	441	......	......	408	......	......	......	......
Oats, pease, and barley, ground, soaked 30 hours	4	66	124	119	1.04	......	467	......	......	376	......	......	......
Oats, pease, and barley, whole, soaked 30 hours	4	66	105	119	.88	409	......	......	388	......	......	......	......
Oats, pease, and barley, ground, dry	4	101	89	76	1.17	......	307	......	......	348	......	......	......
Oats, pease, and barley, whole, dry	4	103	82	76	1.08	307	......	......	360	......	......	......	......
Average, 10 tests, with 69 pigs	......	......	......	......	......	......	......	......	473	415	......	......	......

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[a] Bul. No. 33, Central Expt. Farm. The mixture of pease, barley, and of rye, and oats, pease, and barley fed in these experiments were composed of equal parts of those grains.

The Colorado Station[a] studied the value of grinding both bald, or beardless, barley and common barley. Four tests were made with bald and three with common barley. The pigs on ground bald barley averaged 60 pounds at the beginning, made an average daily gain of 0.77 pound, and consumed 320 pounds of grain and 100 quarts of skim milk for each 100 pounds of gain. Those on whole bald barley averaged 58 pounds at the beginning, made an average daily gain of 0.65 pound, and consumed 370 pounds of grain and 180 quarts of skim milk for each 100 pounds of gain. The pigs on common barley averaged 43 pounds at the beginning. Those on ground grain made an average daily gain of 0.47 pound, and consumed 470 pounds of grain and 90 quarts of milk for each 100 pounds of gain. Those on whole grain made an average daily gain of 0.44 pound, and consumed 520 pounds of grain and 90 quarts of milk for 100 pounds of gain.

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[a] Bul. No. 40.

These results show a somewhat wider variation between the feeding values of whole and ground small grain than those from the experiments with corn. It should be also noted that the results are much more uniformly favorable to grinding. The approximate averages are 473 pounds of whole grain per 100 pounds of gain and 415 pounds of ground grain per 100 pounds of gain, showing an advantage in favor of grinding of 12.26 per cent.

DRY COMPARED WITH SOAKED FEED.

The general custom of soaking grain has received considerable attention from the experiment stations. In some localities a sentiment in favor of feeding meal dry is gaining ground, and some experiments have shown an advantage for this method of feeding. Pigs have been fed to compare wet and dry meal as follows:

The Indiana Station fed two lots of pigs on a mixture of equal parts of corn meal and shorts, which toward the end of the experiment was changed to hominy meal and shorts. Lot I received dry meal and Lot II received meal mixed with an equal weight of water. Both lots received all the water they desired in addition to that in the feed.

Two tests were made at the Wisconsin Station. In the first a ration of equal parts of corn meal and shorts was fed with water as wanted. In the second trial the grain was 2 parts of corn meal and 1 of shorts. Salt and hardwood ashes were supplied to all lots. In both trials Lot I received dry feed and Lot II wet feed.

In Minnesota 12 pigs were fed a ration of 2 parts of corn meal, 2 parts of shorts, and 1 part of old-process linseed meal. Two lots had their meal mixed into a thick slop with cold water, the others were fed dry.

At the Missouri Station two lots were fed wheat chops and two others a mixture of 4 parts whole wheat and 1 of bran. The wet grain was fed after being soaked thirty-six hours. The pigs, which were high-grade Berkshires, were fed in pens open to the south, and they had access to troughs in which was a mixture of hardwood ashes, coal, and salt.

In Utah three tests are reported. In the first, two lots were fed a ration of equal parts of wheat and bran in yards; in the second, two lots of pigs were fed a balanced ration of corn meal and bran, which was changed in proportion as age and weight increased; the meal to the wet-feed lot was thoroughly mixed with water, but not soaked; in the third experiment, three lots of pigs received a ration of equal parts by weight of bran and chopped wheat. Lot I received meal that had been soaked twelve hours; Lot II, meal wet just before feeding; and Lot III, dry meal.

The Oregon Station fed 4 well-bred Berkshire pigs, two and one-half months old, at the beginning of the experiment. They received a ration of shorts from July 1 to September 5, and after the latter date a ration of equal parts by weight of chopped wheat, oats, bran, and shorts. The meal to the lot on wet feed was "thoroughly wet with cold water and allowed to stand from one feeding time to the next." Charcoal and ashes were given two or three times each week.

A brief experiment of this character that was conducted by a third-year student as thesis work at the Ontario Agricultural College is noted in the report of that institution for 1900. The hogs in both lots were of similar breeding and were fed a meal mixture of wheat and barley.

The Canada Central Experimental Farm fed four lots of pigs on a mixture of equal parts of pease, barley, and rye as follows: Lot I received whole grain soaked thirty hours, Lot II received whole grain dry, Lot III received ground grain soaked thirty hours, and Lot IV ground grain dry.

The results of all these experiments are shown in the following table:

Results of experiments with dry and wet feed.

Ration.	Number of hogs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Dry.	Wet.	Soaked.	Dry.	Wet.	Soaked.
Indiana:[a]											
Corn meal or hominy meal and shorts, equal parts—		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Dry	4	60	634	146	1.08	2,282	......	......	359	.....	.....
Wet	4	59	645	146	1.10	......	2,451	......	.....	380	.....
Wisconsin:[b]											
Corn meal and shorts, equal parts—											
Dry	3	115	255	68	1.25	1,228	......	......	482	.....	.....
Wet	3	115	337	68	1.65	......	1,361	......	.....	404	.....
Corn ⅔, shorts ⅓—											
Dry	2	169	161	68	1.18	983	......	......	611	.....	.....
Wet	2	169	220	68	1.62	......	1,040	......	.....	473	.....
Minnesota:[c]											
Corn meal 2, shorts 2, linseed meal (O. P.) 1—											
Dry	3	29	246	112	.73	1,085	......	......	441	.....	.....
Do	3	33	249	112	.74	1,141	......	......	458	.....	.....
Wet	3	34	343	112	1.02	......	1,501	......	.....	438	.....
Do	3	30	269	112	.80	......	1,234	......	.....	459	.....

[a] Bul. No 86. [b] Fifth An. Rpt. [c] Bul. No. 22.

Results of experiments with dry and wet feed—Continued.

Ration.	Number of hogs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Dry.	Wet.	Soaked.	Dry.	Wet.	Soaked.
Missouri:[a]											
Wheat chop—		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*
Dry	3	111	562	99	1.89	2,340			416		
Wet	3	112	605	99	2.04		2,420			400	
Whole wheat ⅔, bran ⅓—											
Dry	3	118	414	99	1.39	2,105			508		
Wet	3	119	373	99	1.26		2,054			550	
Utah:[b]											
Wheat and bran, equal parts—											
Dry	2	83	296	112	1.32	1,292			436		
Wet	2	69	311	125	1.25		1,462			470	
Corn meal and bran—											
Dry	3	99	202	75	.90	998			494		
Wet	3	96	171	75	.76		868			508	
Bran and chopped wheat, equal parts—											
Dry	3	91	216	110	.65	1,389			643		
Wet	3	93	271	110	.82		1,422			525	
Soaked	3	86	234	110	.71			1,360			581
Oregon:[c]											
Mixed grain—											
Dry	2	63	453	182	1.24	2,116			467		
Wet	2	61	527	182	1.45		2,320			440	
Ontario Agricultural College:[d]											
Wheat and barley—											
Dry	4			49	1.04				452		
Wet	4			49	.96					489	
Ottawa:[e]											
Pease, wheat, and barley, whole—											
Dry	4	67	432	119	.90	1,764			408		
Wet	4	66	420	119	.88		1,636			388	
Pease, wheat, and barley, ground—											
Dry	4	69	504	119	1.06	1,800			356		
Wet	4	66	496	119	1.04		1,868			376	
Average of 12 tests, with 89 pigs									444	434	

[a] Bul. No. 29. [b] Bul. No. 70. [c] Bul. No. 28. [d] An. Rpt. 1900. [e] Bul. No. 33.

These results show an advantage of slightly over 2 per cent in favor of soaking as compared with feeding dry. The results at Ottawa and in Missouri are worthy of particular notice. Grisdale[a] calls attention to the fact that in the Ottawa experiments a loss is shown by soaking ground grain, but the whole grain returned the better gains when fed soaked, and suggests that the result from soaking meal may not be so marked as from soaking whole grain. The Missouri results seem to present contradictory evidence in the second test, where four-fifths of the ration was whole wheat. The Utah results of soaking the meal twelve hours should be noted. They are not included in the average; if this were done, the balance would be more favorable to dry feeding.

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[a] Bul. No. 33, Central Expt. Farm.

Two experiments carried on at the Illinois Experiment Station[a] to compare soaked and dry shelled corn gave rather indefinite results. Four pigs, fed in pens, were used in each case, 2 being fed on soaked shelled corn and 2 on dry shelled corn. They had no other feed. The first test lasted from April 29, 1889, to May 27, 1889; the second, from June 10 to July 22, 1889. In the second trial the pigs were well fattened when the experiment commenced. Sixty pounds of corn were put in water at one time, at the rate of 1 bushel of shelled corn to about 8 gallons of water, and taken out as needed for feeding. The daily gains favored the pigs on soaked corn in both tests; but in the first test there was an advantage of about 4½ per cent in favor of soaking, while in the second there was an advantage of about 6½ per cent in favor of the pigs on dry corn.

THE EFFECT OF WATER CONTENT OF SLOP.

In Indiana Plumb and Van Norman[b] fed 16 purebred pigs in order to study the effect of water content of slop. The breeds were Chester White and Berkshire. They were divided into four lots of 4 pigs each, with 2 of each breed in each lot. They were of September and October farrow, and the feed was equal parts of corn meal and shorts for the greater part of the experiment. For a time hominy meal was substituted for the corn meal. They were fed as follows: Lot I, dry feed; Lot II, feed mixed with twice its weight of water; Lot III, feed mixed with three times its weight of water. Each lot was given all the water that was desired in addition to that contained in the feed; records were kept of all water drank. Salt and ashes were accessible. Health was good during the entire experiment. The following table shows the results:

Effect of water content of slop fed to pigs.

Ration.	Number of pigs.	Average weight beginning.	Total gain.	Average daily gain.	Feed per 100 pounds gain.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Meal (dry)	4	60	634	1.08	359
Meal 1, water 1	4	59	645	1.10	380
Meal 1, water 2	4	60	651	1.10	374
Meal 1, water 3	4	60	614	1.05	375

Aside from the apparent advantage in favor of dry feeding, at least in this experiment, the water content seems to have very little influence on the gains when both rate of gain and feed per 100 pounds of grain are considered.

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[a] Bul. No. 16.

[b] Bul. No. 86, Indiana Expt. Sta.

FERMENTED AND UNFERMENTED BRAN.

Burkett,[a] in New Hampshire, fed two lots (3 in each lot) of Berkshire-Chester White pigs for ninety-nine days in order to compare the effect of fermented bran in a pig's ration. Lot I received fermented bran and skim milk; Lot II received unfermented bran and skim milk. The bran was steamed in a barrel and left for ten days before it was used. The results follow:

Feeding fermented and unfermented bran to pigs.

Ration.	Number of pigs.	Average weight beginning.	Total gain.	Average daily gain.	Feed per 100 pounds gain.	
					Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Fermented bran	3	47	181	0.61	291	906
Unfermented bran	3	48	208	.70	322	928

It is said to be the practice of some New Hampshire farmers to allow bran to ferment before it is fed to pigs, and this experiment was conducted in order to test the value of this practice. The pigs on fermented bran seem to have an advantage in the economy of gain, but their gains were smaller.

WIDE AND NARROW RATIONS.

The Wisconsin Station[b] recently reported four experiments, the object of which was to compare the feeding value of wide and narrow rations. The first compared a ration of equal parts of corn meal and skim milk with one of equal parts of ground pease and wheat middlings plus an equal weight of skim milk. The pigs were Poland Chinas and Large Yorkshires, both breeds being represented in each lot. Each lot had a pen 12 feet square, having a clay floor, and opening into a yard of the same size. Salt and wood ashes were often given.

The second experiment[c] compared a ration of equal parts of corn meal and ground rye with one composed of one-third ground pease and two-thirds wheat shorts. The meal was mixed with water just before feeding and formed a thin slop. The pigs had access to coal ashes and salt, and by subdividing the feeding pens at meal time each pig was fed separately. A pen 12 feet square, with clay floor, and opening into a small yard was allowed each lot. There were 10 pigs—2 Berkshires, 2 Poland Chinas, 2 Yorkshires, and 4 crossbred "razorback" Poland Chinas. These crosses were by an Indian Territory native boar (the typical razorback of the South), out of a "fine-boned, short-bodied Poland China sow." The lots were as equal as possible as regarded size, age, condition, and breed.

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[a] Bul. No. 66, New Hampshire Expt. Sta.

[b] Seventeenth An. Rpt.

[c] Eighteenth An. Rpt., Wisconsin Expt. Sta.

In the third experiment[a] pea meal and corn meal were compared. The pigs used were Yorkshires, Berkshires, razorbacks, and crosses of the razorback with Berkshires and Poland Chinas. They were divided into lots as nearly equal in all respects as possible, and were confined in a similar manner to those in the preceding experiment.

The fourth experiment[b] also compared ground pease and corn meal. The pigs were Berkshires, Poland Chinas, razorbacks, and crosses of these lard type breeds with razorbacks. The grain was made into a slop just before feeding time and the pigs were confined in a similar manner to those in the preceding experiment. Each pig had wood ashes and salt and a plentiful supply of water.

The following table shows some of the results of these experiments:

Feeding pigs on wide and narrow rations.

Ration.	Total gain per head.	Average daily gain.	Average daily amount grain eaten.	Feed per 100 pounds gain.	Digestible protein in 100 pounds feed.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Wide ration:					
Corn meal and skim milk	158.76	1.26	3.92	632	3.35
Corn and rye meals	80.8	.96	5.3	552	8.9
Corn meal	117.7	.63	3.07	491	7.9
Corn meal	130.8	.62	3.28	606	7.0
Narrow ration:					
Pease, middlings, and skim milk	147.75	1.17	3.94	681	8.85
Pease and shorts	48.4	.62	4.68	762	13.7
Pease	143.1	.75	3.96	452	16.8
Pease	140.6	.84	4.14	495	16.8

Ration.	Digestible carbohydrates in 100 pounds feed.	Digestible fat in 100 pounds feed.	Digestible protein for 100 pounds gain.	Digestible carbohydrates for 100 pounds gain.	Digestible fat for 100 pounds gain.	Nutritive ratio.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Wide ration:						
Corn meal and skim milk	35.85	2.3	33.84	223.41	14.33	1:7.7
Corn and rye meals	67.1	2.7	49.13	370.39	14.90	1:8.2
Corn meal	66.7	4.3	38.789	327.497	21.113	1:9.75
Corn meal	66.7	4.3	47.874	404.202	26.058	1:9.75
Narrow ration:						
Pease, middlings, and skim milk	28.8	1.18	60.14	196.59	8.05	1:3.6
Pease and shorts	50.6	2.7	104.39	385.57	20.57	1:4.1
Pease	51.8	.7	75.936	234.136	3.164	1:3.18
Pease	51.8	.7	83.16	256.41	3.465	1:3.18

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[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

[b] Nineteenth An. Rpt., Wisconsin Expt. Sta.

During the last two years of the pig-feeding experiments where the comparison of breeds was studied, the Iowa Station[a] fed two lots of similarly bred Duroc Jersey pigs to compare wide and narrow rations. The following table shows the results at this station:

Feeding pigs on wide and narrow rations.

Ration.	Number of pigs.	Average weight beginning.	Total gain.	Number of days fed.	Average daily gain.
Wide:		*Pounds.*	*Pounds.*		*Pounds.*
First experiment	5	38	1,056	153	1.38
Second experiment	5	22	805	163	.98
Narrow:					
First experiment	5	35	967	153	1.28
Second experiment	5	22	746	163	.92

Ration.	Digestible dry matter per 100 pounds gain.	Cost of feed per 100 pounds gain.	Selling price per 100 pounds.	Dressed weight.	Nutritive ratio.
Wide:	*Pounds.*	*Dollars.*	*Dollars.*	*Per cent.*	
First experiment	319	1.84	3.70	79.3	1:7.8
Second experiment	448	2.23	3.55	77	1:7.7
Narrow:					
First experiment	328	1.93	3.70	77.1	1:4.1
Second experiment	487	2.68	3.55	74.1	1:4.9

The most striking feature of these results is the advantageous showing of the pigs on the wide rations. In the Wisconsin tests those pigs on corn meal and skim milk made larger, more rapid, and more economical gains than those on pease, middlings, and skim milk, and the same was true of those on corn meal and rye compared with pease and shorts. The rations were not excessively unbalanced in either case, the wide ones being 1:7.7 and 1:8.2 and the narrow ones 1:4.1 and 1:3.6. In both Iowa experiments there is a decided advantage in favor of the pigs receiving the wide rations. They made the largest and most rapid gains, fed more economically, both in feed eaten and money cost of feed, but sold at the same price on the market. The third and fourth Wisconsin experiments gave better returns for pease alone (a narrow ration) than for corn alone (a decidedly wide ration). These tests show, pound for pound, a greater value for pease than for corn, but it is suggested that, considering market prices of feed, corn is the cheaper. The better appetite of the pease-fed pigs was remarked upon in both tests, but especially in the last one. Some investigators have not found pease to be successful when fed alone. Day[b] states that at Guelph pea feeding resulted in poor gains and unthrifty animals, but feeding a mixture of 3 parts pea meal and 1 part middlings gave good gains and produced excellent bacon.

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[a] Bul. No. 48, Iowa Expt. Sta.

[b] An. Rpt. 1899, Ontario Agr. Coll.

The effect of the narrow rations on the external appearance of the pigs was noted in the Wisconsin experiments.[a] Toward the end of the experiment, when pea meal and shorts were compared with corn meal and rye meal, the luxuriant hair and smoother flesh of the pea-fed pigs were remarked upon. The corn-fed pigs were less smooth, had deeper wrinkles, and the flesh showed a tendency to be soft and roll over the shoulders and flanks.

LIMITED COMPARED WITH UNLIMITED RATIONS.

The utility of feeding hogs on a ration which contains a quantity somewhat less than they might consume if the opportunity were afforded has been studied from two standpoints.

THE VALUE OF A SLIGHTLY REDUCED RATION.

Recognizing the necessity, under Canadian conditions, of producing a finished pig of 175 to 190 pounds weight, with a thickness of fat on the back not to exceed 1½ to 2 inches, Grisdale[b] fed three lots of pigs to determine the effect of a slight reduction of the feed. Those of one lot had all the grain they would eat up clean, and the others received somewhat less than this amount. The ration of the one lot was about 4¼ pounds of mixed grain and about 3⅓ pounds of skim milk daily, and that of the others was about 4 pounds of mixed grain and the same amount of skim milk daily. The following table is submitted as a tentative study of the subject:

Effect of a slight reduction in the ration of pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average net gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.	Average amount feed per 100 pounds gain.
		Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Oats, pease, barley, whole; amount limited	4	103	185	82	76	1.08	307	360
Skim milk, limited							254	309
Oats, pease, barley, ground; amount limited	4	101	190	89	76	1.17	307	343
Skim milk, limited							254	285
Oats, pease, barley, ½ ground, ½ whole; amount unlimited	4	103	188	85	76	1.11	326	384
Skim milk, limited							254	299

Although the statement is made that these results are not to be regarded as conclusive, this table affords material for interesting study. The limited ration lots made better net gains, better daily gains, and pork at a less cost of feed per 100 pounds gain than the unlimited ration lot. The influence of the ground feed on the second lot had, of course, the effect of causing a better showing over the first lot, but this influence of ground feed is not so apparent in the last test.

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[a] Seventeenth An. Rpt., p. 18.

[b] Bul. No. 33, Central Expt. Farm.

FEEDING WITH A GREATLY REDUCED RATION.

In Utah, Foster and Merrill made exhaustive studies of the utility of a scanty ration as compared with an unlimited one, and also the value of a period of partial starvation followed by one of unlimited feeding. This is obviously a decidedly different problem from that of the Canadian station. It is held by some feeders that pigs do better on scanty feed than on a liberal supply, and it is also held that when a period of insufficient nourishment is followed by one of full feeding the great gains made on full feed more than compensate for the loss while on the light ration.

The Utah results show the effects of partial-grain rations as compared with full-grain rations during five years while pigs were on pasture; also two years' work showing the effect of full feeding following partial feeding, the pigs having pasture during both tests, and also the effect of full feeding following pasture alone.

The usual plan was to feed one lot of pigs all the grain they would eat without waste; this was known as a "full-grain ration." The "three-fourths ration," "one-half ration," and "one-fourth ration" were computed from the full ration as a standard. These large reductions put the Utah results on a different basis from those of the Canada station.

Effects of partial-grain rations with pasture.—The following table shows the results of the five years' work with pigs receiving full and partial grain rations on pasture:[a]

Feeding pigs on full rations and greatly reduced rations.

Ration.	Total gain.	Average daily gain.	Grain eaten daily.	Grain per 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Full-grain ration	299	1.21	4.56	374
Three-fourths ration	248	1.01	3.64	354
One-half ration	186	.75	2.83	302
One-fourth ration	119	.55	1.85	247

Following a limited ration with full feeding.—Foster and Merrill[a] studied the after effects of partial grain rations by placing pigs on full and partial grain rations for a time, and following this period with one in which all the lots had a full ration.

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[a] Bul. No. 70, Utah Expt. Sta.

There were 6 pigs in each lot; they were purebred and high-grade Berkshires, with a few purebred Poland Chinas; were fourteen weeks old when the experiment began, and had run on pasture with their dams. During the experiment they had the run of a good alfalfa pasture. The grain fed was chopped wheat and bran, equal parts by weight.

Lot I received all the grain they would eat.

Lot II received three-fourths as much grain as Lot I.

Lot III received one-half as much grain as Lot I.

Lot IV received one-fourth as much grain as Lot I.

The second period began immediately at the close of the first and continued six weeks. During this period the grain ration was unchanged; the pigs still had the run of pasture, but all the lots received as much grain as they would eat—that is, a full ration.

The following table gives a comparative statement of results for the entire experiment:

Following a limited ration with full feeding.

Ration.	Number of pigs.	Total weight at beginning.	Average daily gain.	Average amount grain eaten daily.	Total feed eaten.	Grain eaten per 100 pounds gain.	Cost per 100 pounds gain.	Profit by periods.	Total profit.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*	*Dolls.*
Lot I:									
First period, full grain ration	6	259	1.18	3.92	1,697	333	2.08	9.77	12.81
Second period, full grain ration	6	786	1.25	6.21	1,697	496	3.10	3.04	
Lot II:									
First period, ¾ grain ration	6	259	.914	2.94	1,273	322	2.01	7.86	11.79
Second period, full grain ration	6	654	1.23	5.58	1,507	452	2.82	3.93	
Lot III:									
First period, ½ grain ration	6	260	.685	1.96	849	286	1.79	6.54	10.38
Second period, full grain ration	6	556	1.19	5.31	1,436	448	2.80	3.84	
Lot IV:									
First period, ¼ grain ration	6	250	.386	.975	424	254	1.59	4.03	8.19
Second period, full grain ration	6	417	1.12	4.74	1,281	421	2.63	4.16	

It will be seen that during the entire experiment the average daily gain varied with the amount of grain received during the first period; the lots receiving the smallest rations during the first period made the cheapest gains, but the advantage in the total profits is with Lot I.

Full rations after pasture.—The effect of a period of full feeding following one of scanty nourishment is strikingly shown in the Utah results[a] with pigs that went through tests on pasture alone. In 1898 one lot of pigs was on a mixed pasture on which were also some cattle and sheep. A second lot was on alfalfa pasture. No grain was given in either case. The lot on mixed pasture made slight gains. Those on alfalfa changed greatly in appearance during the experiment and lost in weight. At the close of the pasture test the pigs were placed in a pen and fed a full ration of grain and dairy by-products. This second period lasted eight weeks.

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[a] Bul. No. 70, Utah Expt. Sta.

In 1899 a similar experiment[a] was conducted, the pigs being on alfalfa pasture. Both lots lost in weight. At the close of the pasture test they were placed in pens and fed all the grain they would eat up clean, having the run of the pasture during feeding times. This period lasted forty-four days. One pig in Lot II failed to thrive and died after the experiment closed. "Postmortem examination showed dry undigested food in the intestines, also the intestines much inflamed."

The following table shows the results of these tests:

Feeding pigs on full grain rations following pasture.

Data.	1898.	1899.	
	Lots I and II.	Lot I.	Lot II.
Total weight at beginning .... pounds..	601	172	299
Total weight at close .... do....	1,310	358	486
Total gain .... do....	709	186	187
Days fed .... number..	56	44	44
Average daily gain .... pounds..	2.11	1.41	1.42
Total feed eaten:			
Milk .... do....	4,101	a673	a862
Whey .... do....	2,751		
Grain .... do....	2,387		
Average amount of feed eaten daily:			
Milk .... do....	12.20	a5.1	a6.53
Whey .... do....	8.19		
Grain .... do....	7.10		
Feed per 100 pounds gain:			
Milk .... do....	578	a363	a461
Whey .... do....	388		
Grain .... do....	337		
Cost per 100 pounds gain:			
Milk .... dollars..	.87	2.26	2.89
Whey .... do....	.27		
Grain .... do....	2.11		

a Grain only.

These experiments seem to point to two conclusions. In the Canadian results a carefully conducted experiment apparently confirms what has frequently been urged by writers on the feeding of both men and the lower animals, namely, that the digestive system will be kept in better tone and will thus be able to do better work if it is not crowded to the limit. The great forcing to which animals are subjected during the fattening process must surely have an effect that is similar to that of high living in man, namely, a derangement of the digestive and circulatory organs; and it is beginning to be questioned whether this process of compelling a pig or a steer or a sheep to eat up to his limit twice or three times a day for several months is economical. The pigs on a limited ration in the Canadian experiment received an average daily amount of grain of only about one-half pound less than those that were eating all they would clean up, and ate in seventy-six days a total of only 19 pounds less grain. Yet in one case the average daily gain was better, and in both the gains were made more economically—384 pounds grain and 299 pounds milk being required for 100 pounds gain with the unlimited ration lot, while 343 pounds grain and 285 pounds milk and 360 pounds grain and 309 pounds milk, respectively, were required for 100 pounds gain with the two lots on the limited ration. This would seem to be a subject worthy of further investigation.

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[a] See pp. 151, 152 for a detailed abstract of these pasture periods.

The Utah results are decidedly against the system of starving animals at any period of their growth. While the economy of the cramming method of feeding may merely be questioned, no one can doubt that the best results in the fattening of animals will come when they are kept gaining up to the close of the feeding period. These experiments were conducted to test the soundness of the claim made by some feeders that the loss due to feeding and extremely light grain rations is more than made up by the large gains made when the animal is given all the grain it will eat, and that a period spent on pasture with little or no grain feeding distends the stomach of hogs by filling them with a mass of bulky feed, and so prepares them to assimilate feed more readily when placed on a full grain ration, to eat more feed, and consequently to make larger and more economical gains. Practically, they were designed to study the utility of a maintenance ration. In the experiment to study the effect of feeding partial grain rations followed by full feeding (pp. 93, 94), the pigs on a full grain ration during both periods made the greatest gains through the entire experiment; but the feed per 100 pounds gain and the money cost per 100 pounds gain varied directly with the amount of the daily ration, the pigs receiving the smallest amount making the cheapest gains. However, the profits on the feeding were greatest with those pigs that were not stinted in their feed, except in the second period, when the pigs that had been on partial rations showed the largest profits. The economy of feeding during the early months of a pig's life is thus exemplified. With the pigs that were on pasture alone, the same is true; a summer of stagnation was counterbalanced by a short period of heavy feeding, enormous eating, and very large gains that nevertheless were not sufficient to make the entire feeding process economical.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 47, PART II.

D. E. SALMON, D. V. M., Chief of Bureau.

THE HOG INDUSTRY.

SELECTION, FEEDING, AND MANAGEMENT.
RECENT AMERICAN EXPERIMENTAL WORK.
STATISTICS OF PRODUCTION AND TRADE.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

CORN AND CORN SUBSTITUTES.

To the farmer of the corn belt those experiments with grains which may take the place of corn for feeding purposes in times of scarcity are always interesting. In seasons such as that of 1901, when a summer of extreme heat and little or no rain follows a spring of normal conditions, the short corn crop is frequently counterbalanced by a bountiful supply of small grains. Many farmers at such times rely on wheat, barley, oats, and rye to carry their stock to marketable condition. Outside the corn-growing districts such experiments are of even more importance, for the small grains are often grown in great abundance and form the basis of all rations.

Wheat compared with corn.—At the Indiana Station[a] Plumb and Anderson fed four lots of 4 Chester White pigs to study the relative value of feeding wheat and corn, both alone and in combination. The pigs were farrowed late in October, and the experiments began as soon as they were weaned, which was early in January. They were out of two sows that were litter sisters. Lot I received whole corn; Lot II received dry whole wheat; Lot III received a ration consisting of equal parts of corn and wheat; Lot IV received soaked whole wheat. Up to March 6 they received 10 pounds of separator milk as a noon feed and after that date 12 pounds of the same daily. They were fed one hundred and five days. The results were as follows:

Wheat compared with corn for pigs.

Lot.	Ration.	Number of pigs.	Weight at beginning.	Weight at close.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.[a]
			Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
I	Corn	4	185	673	105	1.16	312
II	Wheat (dry)	4	175	607	105	1.02	355
III	Corn and wheat, equal parts	4	174	646	105	1.12	323
IV	Wheat (soaked)	4	189	633	105	1.05	355

[a] Digestible dry matter.

At the Utah Station, Foster and Merrill[b] conducted similar work in comparing ground wheat with corn meal. Two lots of 3 pigs each were fed, in covered pens, all the ground grain they would eat. The results follow:

Ground wheat compared with corn meal for pigs.

Ration.	Number of pigs.	Weight at beginning.	Weight at close.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
Corn meal	3	290	519	91	0.85	558
Ground wheat	3	291	615	91	1.20	464

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[a] Bul. No. 67.

[b] Bul. No. 70.

At the usual price of corn and wheat, 75 cents per hundredweight, the cost of gain for the corn-fed lot is given as $4.18 per 100 pounds, and that of the wheat-fed lot at $3.48 per 100 pounds.

At the close of this test a second one was made, but the ration of the first lot was made equal parts of corn meal and pea meal after the middle of the test. The results follow:

Ground wheat compared with corn and pea meals for pigs.

Ration.	Number of pigs.	Weight at beginning.	Weight at close.	Number of days fed.	Average daily gain.	Pounds feed per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
Corn and pea meals	3	260	670	115	1.12	407
Ground wheat	3	257	587	115	.96	403

Wheat compared with various other grains.—At the Nebraska Station, Smith[a] fed eight lots of 6 pigs each to study the comparative feeding value of wheat, rye, and corn, both alone and in combination. Charcoal and lime were fed occasionally. Four pigs in each lot were of the bacon type—Tamworth and Yorkshire—and two were of the fat, or lard, type, or "block" type, as the author expresses it. Each lot had an 8 by 12 foot cement-floored pen in a closed shed, with an 8 by 16 foot yard adjoining. The ground feed was mixed into a thick slop after being weighed; the soaked wheat was weighed before being soaked. The first cost of the pigs was $4.50 per 100 pounds and they were sold on the farm at $5.52½ per 100 pounds. Corn and wheat were charged at 55 cents per bushel, rye at 50 cents per bushel, and shorts at $18 per ton. Grinding was charged at 8 cents per 100 pounds for wheat and rye and 6 cents per 100 pounds for corn. A statement of the results follows:

Wheat compared with other grains for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.	Feed per 100 pounds gain.	Profit per lot.
		Lbs.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Whole wheat, dry	6	110	167.0	342	91	0.63	2,178	637	5.72
Whole wheat, soaked 18 to 24 hours	6	110	174.0	385	91	.70	2,210	575	7.81
Ground wheat	6	108	177.0	414	91	.76	2,317	559	6.43
Ground wheat and corn, equal parts	6	111	178.0	401	91	.74	2,351	586	6.03
Ground wheat and rye, equal parts	6	107	170.7	383	91	.70	2,376	621	4.34
Ground wheat and shorts, equal parts	6	109	174.0	388	91	.71	2,375	612	5.65
Ground corn	6	110	174.5	387	91	.71	2,356	609	3.60
Ground rye	6	107	168.0	367	91	.67	2,290	624	4.55

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[a] Bul. No. 75.

In this experiment ground wheat gave the greatest returns for the least amount of grain, but did not return so large a profit as whole soaked wheat, owing to the expense of grinding. The undesirability of feeding whole wheat dry seems to be indicated by these results. Ground wheat and corn gave considerably better returns than ground wheat and rye or ground wheat and shorts. Ground corn and rye alone do not appear to advantage.

These results show wheat to have a feeding value fully equal to that of corn, and are in line with the work that has been previously published on this subject. In the first Utah test, wheat showed a very much better and cheaper gain than corn, but when pea meal was added to the corn-meal ration, wheat did not have so great an advantage. The Nebraska results are specially favorable to wheat feeding.

Feeding frosted wheat.—Nine experiments with wheat that had been more or less damaged by frost were conducted at the Central Experimental Farm of Canada.[a] The grain was fed alone, ground, unground, and in combination with other grains and skim milk.

The following shows the results and conclusions from the experiments:

Frosted wheat for pigs.

Experiment.	Ration.	How prepared.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average net gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.	Feed per 100 pounds gain.
				Lbs.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*
1	Wheat	Ground, soaked 12 hours.	4	185	275	90	77	1.17	479	530
2	....do	Whole, soaked 42 hours.	4	186	273	86	77	1.11	570	659
3	Wheat, barley, and pease.	....do	4	187	278	92	77	1.19	557	607
4	Wheat	Ground, soaked 12 hours.	5	61	165	104	120	.87	441	423
5	....do	....do	4	104	192	88	56	1.57	233	265
	Skim milk								1,011	1,251
6	Wheat	Ground, soaked 18 hours.	12	108	187	84	84	1.00	442	526
7	Wheat and barley	Ground, soaked 30 hours.	21	117	179	62	84	.73	326	445
	Carrots								53	85
8	Barley, wheat, rye, and bran.	Ground, soaked 12 hours.	36	54	108	54	105	.51	207	385
9	Barley, rye, wheat, and bran.	....do	31	108	191	83	83	1.00	268	323
	Skim milk								250	300

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[a] Bul. No. 33.

The fact that this wheat had been injured by frost does not seem to have had a serious effect on its feeding value. In the majority of instances the gains made were satisfactory, and those cases in which a large amount of grain was required for 100 pounds of gain were generally with hogs of considerable maturity and consequently expensive feeders.

Barley compared with corn.—The following results were obtained with barley alone in comparison with corn alone in South Dakota, Colorado, and Canada:

Barley compared with corn for pigs.

Ration.	Number of tests.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.		
							Corn.	Barley.	Milk.
Colorado: [a]			*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Whole corn	6	....	71	....	....	0.39	700	....	[e]110
Ground corn	5	....	60	....	....	.46	540	....	[e]110
Whole bald barley	8	....	88	....	....	.58	....	500	[e]130
Ground bald barley	5	....	67	....	....	.74	....	360	[e]80
Whole common barley	4	....	68	....	....	.49	....	540	[e]70
Ground common barley	4	....	47	....	....	.70	....	430	[e]110
South Dakota: [b]									
Corn meal	1	5	126	430	56	1.53	453	....	....
Barley	2	9	112	803	56	1.59	....	457	....
Ontario Agricultural College: [c]									
Corn	....	....	....	....	....	.70	547	....	....
Barley	....	....	....	....	....	1.17	....	456	....
Central Experimental Farm, Ottawa: [d]									
Whole corn	1	3	72	354	91	1.30	290	....	231
Ground corn	1	4	74	392	112	.87	416	....	....
Whole barley	1	4	99	400	84	1.19	....	364	252
Ground barley	1	4	73	444	112	1.00	....	435	....

[a] Bul. No. 40.

[b] Bul. No. 63.

[c] An. Rpts., 1899 and 1900.

[d] Bul. No. 33.

[e] Quarts.

This table does not present an accurate comparison between barley and corn, as skim milk enters into the results in five instances when barley was fed, as against only three instances where corn was fed, but the results command interest in showing that the value of barley for hog feeding compares very favorably with that of corn.

Barley compared with corn, in combinations.—The South Dakota Experiment Station and the Ontario Agricultural College have reported tests with barley in combination with such feeds as shorts and middlings.

[End of Part I.]

The following table shows the results:

Barley compared with corn, with shorts or middlings for pigs.

Ration.	Number of tests.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
							Corn.	Barley.
South Dakota:[a]			*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*
Corn and shorts equal parts	2	9	111	840	56	1.67	413	....
Barley and shorts equal parts	4	17	115	1,561	56	1.64	....	456
Ontario Agricultural College:[b]								
Corn and middlings	1	11	63	....	....	.79	480	....
Do	1	12	....	....	140	.817	482	....
Do	1	5	55	664	....	.677	[c]424.55	....
Barley and middlings	1	13	63	....	....	.80	....	490
Do	1	12	....	....	140	.841	....	430
Do	1	4	42	501	....	.639	....	[c]439.22

[a] Bul. No. 63.
[b] An. Rpts., 1899 and 1900.
[c] Dry matter.

These results are not so favorable to barley as those of the preceding table, but it can also be said, in the light of these figures, that barley is nearly if not quite equal to corn for feeding pigs, judging it solely from the standpoint of rate and economy of gain, and if we take into consideration its effect on the carcass, it far surpasses corn as a high-grade pig feed. An experiment with purebred hogs at the Ontario Agricultural College, which is not included in the foregoing table, compared barley and corn. Some middlings and skim milk were given, but during the last month the grains were fed alone. While receiving middlings and skim milk the pigs on corn made the most economical gains, but after the middlings and skim milk were withdrawn the pigs on barley made the most rapid and economical gains. The experience of this institution places barley at the head of the list of American bacon-producing feeds.

Ground wheat and barley compared with shelled corn.—At the Colorado Station Buffum and Griffith[a] fed two lots of pigs to compare the feeding value of home-grown Colorado grains with corn, which must be imported from States further east. The pigs used were rather ordinary grade Poland Chinas and Berkshires, about eight months old at the beginning of the experiment. One lot was fed shelled corn; the other, a mixture of equal parts of ground wheat and barley. The wheat and barley were grown on the college farm. "The wheat was the common Defiance variety and was grown in a field producing 34 bushels per acre. The barley was of the common hulled variety and was grown in a field that produced 25 bushels per acre."

The pigs were kept in pens of equal size, each pen with a yard adjoining. The pens were well bedded with straw. Water was given in abundance and occasionally coal and ashes. The following table shows the results:

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[a] Bul. No. 74.

Ground wheat and barley compared with shelled corn for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount of feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.	Profit at 7 cents per pound.
						Corn.	Wheat and barley.	Corn.	Wheat and barley.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dols.*	*Dols.*
Corn	4	95	71.25	101	0.70	383.50	--------	540	--------	7.00	0.95
Wheat and barley	4	94.5	120.25	104	1.16	--------	546.50	--------	450	4.50	3.90

This experiment shows a mixture of wheat and barley to be much more valuable than corn alone for pig feeding. It also speaks very well for the econony of pork production in those States where corn is not a staple crop. Buffum and Griffith state that it is a common practice in the neighborhood of Fort Collins for farmers to exchange barley or wheat for corn on even terms, and even when corn is high in price and wheat and barley cheaper, they will sell the cheaper home-grown grains and buy the expensive one. They give the average price for ten years of these grains in Colorado as 80.5 cents per 100 pounds for corn, 99.5 cents per 100 pounds for wheat, and 55.1 cents per 100 pounds for barley. They ask, very pertinently, whether Colorado feeders have not the solution of the problem of a supply of concentrates for pork production when home-grown grains sell on the farm for less money per 100 pounds than corn can be purchased in town, and especially when either wheat or barley is equal to corn for this purpose and in combination are superior to it.

Oats compared with corn.—Grisdale[a] reports a comparison of oats and corn. The grain was fed whole and was soaked fifty-four hours before feeding. Both lots received skim milk in addition. The results were as follows:

Oats compared with corn for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
							Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Oats	4	97	170	73	84	0.87	421	345
Corn	3	72	190	118	91	1.30	290	231

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[a] Bul. No. 33, Central Expt. Farm.

The results of this test are not very favorable to oats as a pig feed. To get even as economical a gain as could be had from corn a feeder would have to get nearly twice as good gains as from the oats; for, pound for pound of nutrient material, oats is about twice as expensive as corn.

Corn and Kafir corn.—The Oklahoma Station[a] compared Indian corn and Kafir corn as follows:

Six pigs, averaging about 135 pounds at the beginning of the test, were fed six weeks on Kafir heads, and made an average daily gain of 1.11 pounds, requiring about 665 pounds of grain for 100 pounds of gain.

Three pigs, averaging 220 pounds at the beginning, made an average daily gain of 1.53 pounds for thirty-five days, and required the equivalent of 494 pounds of shelled corn for 100 pounds of gain. These same pigs were then fed Kafir meal for two weeks and made 1 pound of gain per head daily, eating 921 pounds of meal for each 100 pounds of gain.

Four pigs, averaging 105 pounds, were fed thirty-five days on Kafir meal. They made an average daily gain of 1.21 pounds, eating 508 pounds of meal for 100 pounds of gain. For the next two weeks they were given soaked shelled corn. They made a total gain of only 30 pounds, eating 707 pounds of corn for 100 pounds of gain. For the next four weeks a daily supply of green alfalfa was given with good effect. A total gain of 140 pounds was made, requiring 365 pounds of grain for 100 pounds of gain.

Kafir corn.—The value of Kafir corn for hogs has been studied extensively at the Kansas Station. Kafir corn was found to have a feeding value considerably below that of corn when both grains were fed alone. In Bulletin No. 95, Cottrell states that the average of a number of trials shows that 527 pounds of Kafir corn and 468 pounds of Indian corn, respectively, are required per 100 pounds of pork made; the yield of pork per bushel of grain being 10.6 pounds in case of Kafir corn and 11.9 pounds with Indian corn. On upland soil, however, the average of eleven years on the Kansas Agricultural College farm shows returns of 46 bushels per acre for Kafir corn and 34½ bushels for Indian corn. Such returns, with gains as noted above, indicate a pork yield per acre of grain at 487 pounds for Kafir corn and 410 pounds for Indian corn. The great value of Kafir corn is its ability to resist drouth.

Soy beans in a Kafir corn ration.—In addition to the lighter returns from Kafir corn than from Indian corn, this grain is very constipating when fed alone, and hogs, especially young ones, tire of it sooner than they do of Indian corn. To remedy these difficulties a mixture is advised, especially with feeds of a laxative nature. One of the most convenient nitrogenous concentrates at the hands of the Kansas farmer is the soy bean. In a series of experiments[a] the effect of such an addition to both Indian corn and Kafir corn rations was studied. The following summary of five experiments shows that soy beans increase gains and diminish the amount of feed required for 100 pounds gain:

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[a] An. Rpt., 1898–99.

Effect of soy beans in a Kafir corn ration for pigs.

Ration.	Average gain.	Increased gain from soy beans.	Feed per 100 pounds gain.	Feed saved by feeding soy beans.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*
First experiment:				
Kafir corn meal	90.6	....	471	....
Kafir corn meal ⅔ Soy bean meal ⅓	103.8	14.6	409	13.2
Second experiment:				
Kafir corn meal	102.0	....	559	....
Kafir corn meal ⅔ Soy bean meal ⅓	145.7	42.8	408	27.0
Third experiment:				
Kafir corn meal	74.2	....	542	....
Kafir corn meal ¾ Soy bean meal ¼	129.2	74.1	374	31.0
Corn meal	82.6	....	484	....
Corn meal ¾ Soy bean meal ¼	120.4	45.5	369	23.7
Fourth experiment:				
Kafir corn meal	52.4	....	749	....
Kafir corn meal ⅔ Soy bean meal ⅓	97.8	86.5	468	37.5
Fifth experiment:				
Kafir corn meal	44.1	....	653	....
Kafir corn meal ⅔ Soy bean meal ⅓	86.6	96.4	435	33.2

The effect of feeding soy beans is good. Hogs receiving them "fatten rapidly, look thrifty, have strong appetites, and the hair and skin are glossy, like those of animals fed oil meal."

The following summary gives a more elaborate comparison of the relative values of Kafir corn or Indian corn meal alone and in combination with soy beans.[a] The results are arranged in order of economy of gains, the total showing the number of pounds of feed required for 100 pounds of gain.

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[a] Bul. No. 95, Kansas Expt. Sta.

Value of soy beans in a Kafir corn or Indian corn ration.

Ration.	Feed per 100 pounds gain.	Ration.	Feed per 100 pounds gain.
	Pounds.		*Pounds.*
Corn meal ⅔, soy bean meal ⅓	369	Kafir corn meal, soaked forty-eight hours	542
Kafir corn meal ⅔, soy bean meal ⅓	374	Kafir corn, whole, soaked forty-eight hours	550
Kafir corn meal ⅔, soy bean meal ⅓	408	Kafir corn meal, wet	559
Kafir corn meal ⅔, soy bean meal ⅓	409	Kafir corn, whole, soaked forty-eight hours	632
Kafir corn meal ⅔, soy bean meal ⅓	435	Kafir corn, whole, wet	638
Kafir corn meal ½, corn meal ½	456	Kafir corn, whole, wet	640
Shelled corn, dry	457	Kafir corn meal, wet	653
Kafir corn meal ⅔, soy bean meal ⅓	468	Kafir corn, whole, dry	655
Kafir corn meal, wet	471	Kafir corn meal, wet	691
Kafir corn meal ½, corn meal ½, wet	477	Kafir corn meal, dry	749
Shelled corn, dry	479	Average	528
Corn meal, soaked forty-eight hours	484		
Kafir corn, whole, dry	512		
Kafir corn meal and cotton-seed meal	540		
Kafir corn, whole, dry	542		

"The six lots of hogs having soy beans as part of their ration required an average of 411 pounds of grain for 100 pounds of gain, while the 19 lots not fed soy beans required an average of 564 pounds of feed for 100 pounds of gain, an increase in food required of over 37 per cent."

Pease compared with wheat.—The Utah Station[a] compared the values of pease and wheat during two years. The pigs were confined in yards and the grain was given whole and dry. The average of results was as follows:

Pease compared with wheat for pigs.

Ration.	Total weight at beginning.	Total gain.	Feed per 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*
Pease	147	303	452
Wheat	136	282	476

Cowpeas alone compared with corn alone.—At the South Carolina Station[b] Newman and Pickett fed to compare cowpeas with corn. The pigs were from eight to eleven months old and were fed in pens. There were 3 pigs in each lot.

The cowpea-fed lot ate 6.7 pounds of cowpeas per head daily and made an average daily gain for the lot of 3.38 pounds. They required 491 pounds of cowpeas to produce 100 pounds of gain.

The corn-fed lot ate 9.2 pounds of corn per head daily and made an average daily gain for the lot of 4.17 pounds. They required 602 pounds of corn to produce 100 pounds of gain.

With pork at 5 cents per pound and corn and cowpeas yielding 15 bushels and 10 bushels, respectively, per acre, the value of an acre of corn in this experiment was $6.97 and that of an acre of cowpeas $6.12.

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[a] Bul. No. 70.

[b] Bul. No. 52.

Ground cowpeas and corn meal compared with corn meal.—At the Alabama Station[a] Duggar fed two lots of pigs to compare the relative value of a ration of half corn meal and half ground pease with an exclusive corn-meal ration. The pigs used were placed in covered pens, with small yards adjoining, and, after a preliminary period of a week, put into the experiment which lasted sixty days. The results are as follows:

Ground cowpeas and corn meal compared with corn meal for pigs.

Ration.	Gain.	Number of days fed.	Feed eaten.	Feed per 100 pounds gain.
	Pounds.		*Pounds.*	*Pounds.*
Ground corn alone	68	60	548	806
Corn ½, cowpeas ½	108	60	570	528

In this experiment the cowpea and corn-meal ration made gains 34 per cent more economical than corn alone. The quality of the pork made was as good as that of corn-fed pork.

Peanuts compared with corn meal.—Duggar[a] placed in pens the pigs used to compare the values of peanut pasture and corn meal (see p. 160) to make a more accurate study of the nutritive values of Spanish peanuts and corn meal. The lots received the same rations, except that the peanuts were dry and fed unhulled. The test lasted six weeks with the following results:

Peanuts compared with corn meal for pigs.

Ration.	Number of pigs.	Number of days fed.	Total gain.	Average daily gain.	Feed per 100 pounds gain.
			Pounds.	*Pound.*	*Pounds.*
Peanuts ½, corn meal ½	3	42	84	0.67	370
Peanuts only	3	42	59.5	.47	280
Corn meal only	2	42	8.6	.10	1,070

This experiment shows the best daily gains from the combination of peanuts and corn meal, and shows the best returns for feed eaten by the pigs on peanuts alone. This lot made very much better gains than the pigs fed exclusively on corn meal, which fed very poorly. The pigs on peanuts alone made a gain of 9 pounds per bushel of peanuts. "This gives a value of 27 cents to a bushel of Spanish peanuts when pork is worth 3 cents per pound gross, and 31½ cents when pork is worth 3½ cents per pound." The unthrifty appearance of the pigs fed on corn meal only was commented upon.

At the South Carolina Station, Newman and Pickett[b] fed two lots of grade Berkshire and Duroc Jersey pigs, from eight to eleven months old, in pens, to study the relative values of peanuts and corn. On land of similar character they estimated the corn yield at 15 bushels per acre and peanuts 90 bushels, and in their investigations they found that, with exclusive corn feeding, 602 pounds of corn were required for 100 pounds of gain and with peanuts 443 pounds for 100 pounds of gain. On this basis, an acre of corn will produce 140 pounds of pork and an acre of peanuts 488 pounds, worth, respectively, when pork is 5 cents per pound, $6.97 and $24.37.

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[a] Bul. No. 93.

[b] Bul. No. 52.

COMMERCIAL BY-PRODUCTS.

One of the prominent features of modern industry is the development of the possibilities of the by-product—the waste and offal of manufacturing establishments. Farmers have long appreciated the value of the by-products of flour mills, but of recent years many other materials have come into the market as valuable feed for farm animals. Rice mills, oil mills, and packing houses all have their by-products, which are useful in supplementing the products of the farm.

MILLING PRODUCTS.

The by-products of the flour mills have for years been bought by farmers for use in the feed box, and one of these—middlings—has come to have an unsurpassed reputation for hog feeding, especially for young animals in the early stages of fattening. With the development of milling the ingenuity of the manufacturer has enabled him to throw a host of new foods upon the market. In consequence, we have, in the first place, a by-product more completely deprived of its nutrient material, perhaps, than formerly, but more uniform in quality; and, in the second place, a greater variety of feeds with which to supply the bins. It is not alone the products of the flour mills that have value for feeding purposes. The rice mills, glucose factories, and oil mills all have by-products that are useful adjuncts to feeding operations. Indeed, most of the experimental work of recent years deals with the value of the by-products of these industries. In the majority of instances these feeding stuffs are best used as adjuncts to corn or corn meal, although often the proximity of feed yards to a mill cheapens the by-products sufficiently to enable the feeder to use them as the main part of the ration.

Bran and corn meal compared with corn meal.—Burkett[a] fed two lots of 3 pigs each, one receiving a ration of equal parts of bran and corn meal and milk and the other corn meal and milk. The object was to compare the value of bran in such a ration and have the corn-fed lot as a check. The results follow:

Bran and corn meal compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
						Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Bran and corn meal	3	47.6	227	99	0.76	308	882
Corn meal	3	47	323	99	1.08	263	663

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[a] Bul. No. 66, New Hampshire Expt. Sta.

This experiment gave much better returns for a corn-meal and skim milk ration than for one where bran was added. Burkett does not value bran highly as a pig feed either alone or in combination with corn meal.

Shorts compared with corn.—At the Colorado Station, Buffum and Griffith[a] fed purebred Berkshire pigs about 5 months old to compare the feeding value of corn meal and shorts in combination with wheat, barley, and oats. One lot received shorts, wheat, oats, and barley in rotation—shorts with wheat and oats one day, with wheat and barley the next, with oats and barley the next, and so on. The lot on corn had the same method of feeding and the same ration, except that corn was fed in place of shorts. Feed was charged at the following prices: Corn, 83 cents per 100 pounds; shorts, 75 cents per 100 pounds; wheat, 95 cents per 100 pounds; oats, $1.20 per 100 barley, $1.20 per 100 pounds. The experiment lasted from March 23 to May 31, 1901—sixty-nine days—the results being as follows:

Shorts compared with corn in mixed rations for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.			Feed per 100 pounds gain.	Cost per 100 pounds gain.
						Corn.	Shorts.	Other grain.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	
Shorts and grain	3	112.5	88.2	69	1.31	......	226.5	225.6	521	$4.70
Corn and other grain	3	98	85.6	69	1.27	208.6	....	209.1	487	4.70

At the Indiana Station Plumb and Anderson[b] fed two lots of 3 high-grade Chester White gilts, each five and one-half months old, to compare the value of a ration of corn meal and wheat shorts with a ration of corn meal only. The mixture was equal parts by weight of corn meal and shorts. The pigs were fed in pens with small shelter houses attached. Shorts were valued at $14 per ton and corn meal at $13.50 per ton. The results were as follows:

Feeding value of wheat shorts.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.	Cost of feed per 100 pounds gain.
						Shorts.	Corn meal.		
		Pounds.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Pounds.*	*Dollars.*
Shorts and corn meal	3	129	354	70	1.69	718	718	406	2.74
Corn meal	3	129	327	70	1.56	....	1,413	482	2.80

The mixture of corn meal and shorts gave larger, more rapid, and more economical gains than a ration of corn meal only. In the Colorado experiments the pigs fed on a ration of shorts made larger and more rapid gains than those on corn meal, but they required more feed per 100 pounds gain.

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[a] Bul. No. 74.

[b] Bul. No. 71.

Corn meal compared with rice meal.—The South Carolina Station[a] compared rice meal and corn meal. "The rice meal is a by-product of the rice mills and consists largely of rice flour, rice polish, and rice bran. As yet the mills have no uniform way of putting it on the market, and, in order that the reader may understand what is meant by rice meal, as used in this experiment, it may be said that it is all the by-product obtained in cleaning the rice grain for the market. Its chemical composition shows that it has about the same amount of protein, carbohydrates, and fat as corn meal."

The pigs used were Berkshires, about five months old, weighing about 90 pounds each. They were given a ration consisting of 1 part meal and 4 parts skim milk, the milk being mixed with the meal, and were confined in pens 20 by 40 feet, with plenty of shade.

The experiment was divided into two periods. During the first period of thirty-nine days Lot I was fed the corn-meal ration and Lot II the rice-meal ration; during the second period of twenty-two days the feed was reversed, Lot I having rice meal and Lot II corn meal.

The results during the first period were not decisive, but during the second they were somewhat favorable to the rice meal.

The results for each kind of grain for the entire experiment are as follows:

Rice meal compared with corn meal for pigs.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost of feed per 100 pounds gain.
					Meal.	Milk.	Meal.	Milk.	
		Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dollars.*
Rice meal 1 part, skim milk 4 parts	3	314.5	61	1.72	779	3,116	248	991	3.84
Corn meal 1 part, skim milk 4 parts	3	303	61	1.66	779	3,116	257	1,028	4.63

The corn meal was valued at $20 per ton, rice meal at $15 per ton, and skim milk at 20 cents per 100 pounds. This experiment shows that rice meal, such as was used in this test, is fully as valuable as corn meal in pig feeding and corroborates previous work along this line.

Feeding value of rice polish.—Owing to the high price of corn during 1902, Duggar[b] devoted considerable attention to the investigation of the value of those feeds whose composition seemed to indicate that they could be used as substitutes for corn meal in pig feeding. In this connection rice polish was fed to a number of pigs under different conditions. Rice polish is a by-product of the rice mills and is difficult to obtain in some sections of the country, as millers often mix it with less valuable by-products and sell the mixture under the name of "rice meal." For this reason rice meal is said to be a variable and uncertain quantity and all samples do not have equal feeding value. In 1902 rice polish was quoted by a Savannah mill at $17.90 per ton, delivered at Auburn, Ala., in less than carload lots. Two years before the same firm had been paid $26 per ton for it delivered at Auburn. It is stated that some of it kept in good condition for more than a year.

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[a] Bul. No. 55.

[b] Bul. No. 122, Alabama Expt. Sta.

Duggar reports seven tests with this by-product. He compared it with corn meal with and without the addition of skim milk, and in a mixed ration of cowpea meal and wheat bran; with a ration of one-half cowpea meal, one-fourth corn meal, and one-fourth rice bran, with the addition of skim milk; and in different proportions with other feeds without skim milk. The pigs used were generally recently weaned and the meal was fed dry. .

The following table summarizes the results:

Feeding value of rice polish.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.		
					Grain.		Milk.
					Rice polish lots.	Other lots.	
		Lbs.		*Pounds.*	*Pounds.*	*Lbs.*	*Lbs.*
Corn meal and skim milk	3	90	35	0.86	....	210	465
Rice polish and skim milk	3	109	35	1.04	170	....	367
Corn meal	3	....	....	....	....	670	....
Rice polish	3	....	....	....	670	....	....
Corn meal	3	54	28	.64	....	501	....
Rice polish	3	79	28	.94	340	....	....
Corn meal	3	68	56	.40	....	621	....
Rice polish	3	132	56	.79	375	....	....
Corn meal 2, cowpea meal 2, wheat bran 1	3	56	28	.67	....	370	....
Rice polish 2, cowpea meal 2, wheat bran 1	3	66	28	.79	310	....	....
Cowpea meal 2, corn meal 1, rice polish 1, and skim milk	3	....	35	....	....	178	413
Rice polish and skim milk	3	....	35	....	193	....	474
Cowpea meal 2, corn meal 1, rice polish 1	3	....	35	....	....	500	....
Corn meal 1, rice polish 1	3	....	35	....	420	....	....

In every instance where data were furnished, the pigs on rice polish show more rapid gains than those on corn meal or mixed grain rations. In only two cases did rice polish fail to prove more economical. One of these was the second test with corn meal, where 670 pounds of feed were required by the pigs on both rations. The other was a test with a mixed ration, where 2 parts cowpea meal, 1 part corn meal, and 1 part rice polish, with skim milk, gave gains at an outlay of 178 pounds grain and 413 pounds skim milk, as compared with 193 pounds grain and 474 pounds skim milk by the ration of rice polish and skim milk.

Duggar summarized the results where rice polish and corn meal were compared directly, and found that an average of 373 pounds of rice polish were required to produce 100 pounds gain, as compared with 474 pounds of corn meal. "At this rate, 78.6 pounds of rice polish were equal to 100 pounds of corn meal, a saving of 21.4 per cent of the grain by the substitution of polish for corn meal."

Gluten meal compared with corn meal.—Pigs that had been fed without success on a potato ration at the Cornell Station[a] were given a "rational ration" of corn meal and skim milk for a week and then they were employed in a test to compare gluten and corn meal. Skim milk was fed, the proportion to meal being about 3 pounds of milk to 1 of meal. Lots I and III received gluten meal and milk, and Lots II and IV corn meal and milk.

Gluten meal was charged at $11.75 per ton, corn meal at $14 per ton, and skim milk at 15 cents per 100 pounds.

The following were the principal results:

Gluten meal compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Dry matter per 100 pounds gain.	Cost per 100 pounds gain.	Dressed weight.	Nutritive ratio.
		Pounds.	*Pounds*		*Pounds.*	*Pounds.*	*Dollars.*	*Per cent.*	
Gluten meal and milk.	4	87.25	214	50	1.07	319	2.70	77.40	1:2.7
Corn meal and milk..	4	90.5	297.5	50	1.49	264	2.50	80.20	1:5.8
Gluten meal and milk.	4	47.5	157.5	50	.79	252	2.40	....	1:2.7
Corn meal and milk..	4	48.5	219	50	1.10	151	1.90	....	1:5.8

The use of gluten meal in combination with skim milk in this experiment did not give results so satisfactory as where corn meal and milk were fed. Both corn meal lots made better gains and the average of dry matter consumed, and cost per 100 pounds gain were much lower than with the pigs on gluten meal and milk.

Hominy meal compared with corn meal.—In Massachusetts the Hatch Station[b] compared hominy meal and corn meal. The latter is described as consisting of "the hulls, germs, and some of the starch and gluten of the corn ground together. This separation is said to be brought about solely by the aid of machinery. The hard flint part of the corn is the hominy, which is used as a human food."

Seven Chester White grades were fed on a grain and skim-milk ration, 7 to 10 quarts of skim milk being fed daily with a grain allowance of 3 to 6 ounces to each quart of milk, depending on appetite and size. One lot received corn meal and milk, and the other hominy meal and milk. The results are shown in the following table:

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[a] Bul. No. 199. Cornell Univ. Expt. Sta.

[b] Eleventh An. Rpt., Hatch Expt. Sta.

Hominy meal compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		Dry matter per 100 pounds gain.
						Grain.	Milk.	Grain.	Milk.	
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	4	56	503	98	1.28	1,022	7,702	208	1,532	321
Hominy meal	3	58	410	98	1.39	766	5,779	187	1,410	306

These figures show hominy meal, as fed in this experiment, to have a feeding value equal to that of corn meal. In this one test corn meal failed to give quite so good results as the hominy meal, showing an average daily gain of 1.28 pounds to 1.39 pounds for hominy meal, and 320 pounds dry matter for 100 pounds gain to 306 pounds dry matter for 100 pounds gain in the case of the hominy meal.

Corn meal compared with cerealine feed.—Two tests were made at the Hatch Station[a] to compare corn meal and cerealine feed. Like hominy meal, cerealine feed "consists also of the hull and a portion of the starch of the corn. It contains rather less of the starch than the hominy meal. It is the by-product resulting from the preparation of the breakfast food known as cerealine flakes. It is very coarse looking and appears very much like unground corn hulls."

In the first test 6 grade Chester White pigs about five weeks old were used. They were fed 6 to 9 quarts of skim milk per head daily, and the grain fed at the start was 3 ounces for each quart of milk; the grain was increased with age and weight. The nutritive ration was 1:3 at the beginning and 1:7 at the close.

In the second test 6 pigs, "a cross between the Poland China and the Chester White," about five weeks old, were fed. Skim milk was fed in connection with the cerealine feed, which was "eaten with seeming relish at all times." The following table shows the results:

Cerealine feed compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		Dry matter per 100 pounds gain.
						Grain.	Milk.	Grain.	Milk.	
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	3	48	413	106	1.30	731	4,827	177	1,169	260
Cerealine feed	3	45	398	106	1.25	731	4,827	184	1,212	277
Corn meal	3	68	315	78	1.34	680	3,061	216	972	281
Cerealine feed	3	67	293	78	1.25	676	3,061	231	1,041	305

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[a] Eleventh An. Rpt., Hatch Expt. Sta.

In these tests cerealine feed showed considerable value as a pig feed, but failed to give as good results, either in rate or economy of gain, as corn meal. Digestion experiments at the Hatch Station with sheep have shown that cerealine feed contains as much digestible matter as corn meal. The station authorities suggest that the coarse nature of cerealine feed lessens its value as a pig feed.

Value of corn hearts.—Duggar[a] fed three lots of 3 pigs each to compare corn hearts with corn meal and cowpea meal. These feeds constituted half the ration, the other half being rice bran. The following table shows the results:

Value of corn hearts.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.	Feed per 100 pounds gain.
		Pounds.		*Pounds.*	*Pounds.*	*Pounds.*
Corn hearts 1 Rice bran 1	3	65	35	0.62	480	738
Cowpea meal 1 Rice bran 1	3	81	35	.77	479	595
Corn meal 1 Rice bran 1	3	98	35	.93	540	550

Analyses at the Alabama Station indicated that the corn hearts used in this experiment contained 8.9 per cent protein and the rice bran 9 per cent protein.

Gluten meal compared with linseed meal for balancing rations.—Patterson, at the Maryland Experiment Station,[b] fed four lots of 5 high-grade Poland China pigs each to compare gluten meal and linseed meal as the nitrogenous components of a ration. Lots I and II received hominy chop three-fifths, linseed meal two-fifths; Lots III and IV received hominy chop three-fifths, King gluten meal two-fifths. Both lots had skim milk in the proportion of 1 pound of milk to 1 of grain. The results were as follows:

Gluten meal compared with linseed meal in a carbonaceous ration.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.		Cost per 100 pounds gain.
						Grain.	Milk.	
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*
Hominy chop ⅗, linseed meal ⅖	5	37	298	60	0.99	242	242	2.71
Hominy chop ⅗, linseed meal ⅖	5	36	294	60	.98	242	242	2.70
Average						242	242	2.70
Hominy chop ⅗, gluten meal ⅖	5	36	241	60	.80	233	233	2.20
Hominy chop ⅗, gluten meal ⅖	5	37	256	60	.85	220	220	2.07
Average						226	226	2.13

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[a] Bul. No. 122, Alabama Expt. Sta.

[b] Bul. No. 63.

This table shows advantages in favor of gluten meal. Both rate and economy of gain favor the corn by-product. The cost of the gluten-meal ration was much less than the one into which linseed meal entered.

COTTON-SEED MEAL.

No feed of the South has so wide a range of interest as cotton-seed meal. It is a concentrated feed of high value for cattle and sheep, and its effect on the fertilizing value of the manure is nearly as great as its effect on the feeding value of the ration.

The influence of cotton-seed meal extends far beyond the States where it is produced, and farmers over the entire country have come to depend upon it to balance their rations and enrich their fields.

Danger of use of cotton-seed meal in pig feeding.—For some reason as yet unexplained this by-product is usually fatal to pigs in from three to ten weeks after feeding has commenced, the mortality being at least 50 per cent. In two tests conducted by the Texas Experiment Station[a] boiled cotton seed gave the least serious results, while soaked raw seed, roasted seed, and raw meal proved more serious. In one test, 10 of the lot of 15 pigs fed cotton seed or cotton-seed meal died. At the Iowa Experiment Station,[b] of 6 pigs that were on a ration of cotton-seed meal, corn-and-cob meal, and buttermilk, 3 died. At the Kansas Experiment Station,[c] 4 young pigs on a ration composed of one-sixth cotton-seed meal and five-sixths corn meal died within forty-six days after feeding commenced. At the Arkansas Station,[d] three lots of 3 pigs each were fed mixed rations, the cotton-seed meal constituting one-third of the grain. All died.

The time intervening between the beginning of feeding cotton seed or cotton-seed meal and the first appearance of trouble varies somewhat. Curtis[e] gives six to eight weeks; Lloyd,[f] in one test, lost the first pig at the end of the fourth week; in another test, deaths began after forty days; Curtiss[g] lost the first pig fifty-one days after feeding commenced. Dinwiddie's[h] first pig died thirty-five days after feeding commenced, and Duggar[i] lost the first pig thirty days after feeding commenced. It therefore appears that there is no very definite period of time that is required for the poison to manifest itself. However, Cottrell[j] states that cotton-seed meal may be fed for three to four weeks before danger is imminent, and Burtis and Malone[k] state that no case has come under their experience "where a pig has died if the cotton-seed meal mixture has not been continued longer than three weeks."

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[a] Bul. No. 21.

[b] Bul. No. 28.

[c] Bul. No. 53.

[d] Bul. No. 76.

[e] Bul. No. 21, Texas Expt. Sta.

[f] Bul. No. 60, Mississippi Expt. Sta.

[g] Bul. No. 28, Iowa Expt. Sta.

[h] Bul. No. 76, Arkansas Expt. Sta.

[i] Bul. No. 122, Alabama Expt. Sta.

[j] Bul. No. 95, Kansas Expt. Sta.

[k] An. Rpt. 1901-02, Oklahoma Expt. Sta.

Symptoms of poisoning.—Poisoning is manifested in a peculiar manner. In many cases pigs that are apparently well in the evening are found dead in the morning, and often the most careful watching fails to show any indications of indisposition. Where symptoms are present those most characteristic seem to be disorder of respiration, which is manifested by quickened breathing, coughing, or hiccough. Failing appetite usually calls the attention of the feeder to the approach of danger. Seldom more than two days intervene between the first symptom and death. Francis[a] gives the following symptoms of the trouble with the Texas pigs:

> The attack was sudden, as a rule; in fact, in a majority of cases an animal was found dead that had been apparently well twelve hours before. In those cases which we were fortunate enough to witness the symptoms were those of a sudden contraction of the diaphragm, producing a sound similar to hiccough in man. The animal stood with head near the ground, the flanks tucked up, the ears hanging pendulous, and the tail straight and limp. Some would lie flat on the belly—never on the side—while others would assume a sitting-up posture with the fore legs well apart. In several cases there was a marked elevation of temperature, the thermometer registering 106° F. per rectum. The circulation seemed very weak and rapid. * * * As a rule they were dead in an hour. * * * The gaspings became more and more frequent and violent, and after a few struggles the animal was dead. In the last moments great quantities of foam or froth would come from the nose or mouth.

The symptoms observed by Dinwiddie[b] are described as follows:

> The disease in all cases was of a type which might be described as acute. In several instances the animals were said to be "off feed" for one or two days before other symptoms were observed. Every animal which exhibited any symptoms at all died within twenty-four hours. It would remain by itself, standing, disinclined to move, breathing with extreme rapidity and jerking or "thumping" in the flanks, and before death frothing at the mouth and nostrils. Fever was absent or but slight; eyes dull and sometimes bloodshot. Coughing occasionally occurred.

Pathological features.—Francis[a] states: "On postmortem examination the digestive organs appeared normal throughout. The other abdominal organs appeared normal. The respiratory organs were full of foam. The lungs themselves were bright red and very much congested and doughy." Mayo[c] pronounced the death of the Kansas pigs to be due in all cases to "congestion and inflammation of the intestines, lungs, and heart;" but Niles[d] could find no assignable cause of death in the case of the Iowa pigs.

Dinwiddie,[b] in the Arkansas experiments, made postmortem examinations of 8 of the 9 pigs which died, and found a very constant condition of disorder. He says, in describing the first examination, the description of which applied to all cases:

> The body presented no external changes. Subcutaneous tissue showed blood extravasations in streaks and points. Blood engorgement of lymph nodes of neck

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[a] Bul. No. 21, Texas Expt. Sta.

[b] Bul. No. 76, Arkansas Expt. Sta.

[c] Bul. No. 53, Kansas Expt. Sta.

[d] Bul. No. 28, Iowa Expt. Sta.

and jaws. Respiratory and buccal mucous membrane dusky red. Pleural cavities contain a large quantity of yellow, cloudy fluid, compressing the lungs to less than half their normal bulk. In the pericardial sac there is a similar dropsical effusion, part of which has formed into a soft, yellowish-white clot. No evident pleuritis. Lung dark red, congested, and collapsed. Cavities of heart contain dark, soft blood clots; slight petechial extravasations on the epicardium. No obvious peritoneal effusion. Liver is dark in color, friable, and deeply blood-engorged, the lobular boundaries on section being unusually prominent, with dark-red depressed centers. Kidneys on section appear congested throughout, capsule nonadherent. * * *

The stomach and intestines often showed abnormal features. The small intestine (jejunum) frequently showed hyperemic patches on both the serous and mucous surfaces, and the large intestine and stomach in several cases contained considerable quantities of gravel. The urine was slightly albuminous in two cases. In one instance, where the brain was dissected, there was engorgement of the veins and sinuses of the dura mater, which extended "backward into the vessels of the neck."

The histological examination is described as follows:

Sections of the liver tissue reveal an intense congestion of the portal system, the intralobular capillaries especially being enormously engorged throughout and the liver cells compressed and shrunken. There is, however, no marked degeneration, and the nuclei take the stain in the normal manner. Sections of the kidney exhibit a similar capillary engorgement, though less intense. The glomerular tufts are compressed by edematous effusion into their capsules. A degenerative process in the cells of the urinary tubules or other marked pathologic changes were not demonstrated. In the spleen no distinct pathologic changes are found. Lung sections show a marked congestion of the capillary vessels, with edematous effusion and occasional blood extravasations, but without cellular proliferation or infiltration. There is no evidence of pneumonia or pleurisy.

Treatment.—As a rule, hogs suffering from the effects of cotton-seed poisoning, if taken from the cotton-seed ration and placed on rich green pasture, become apparently well in a week.[a] A similar result follows when they are simply deprived of the cotton-seed meal of the ration and given an ordinary grain ration. However, Burtis[b] reports a case where a pig died during the winter after a week's feeding on a straight corn diet that followed four weeks' feeding on a ration of one-fifth cotton-seed meal and four-fifths corn meal; and Dinwiddie and Duggar had similar experiences. In some cases pigs may pass through a season of cotton-seed meal feeding and thereafter be indifferent to it. Curtis[c] found that if a pig lived thirty days after the first appearance of trouble it could be regarded as immune from the effects of cotton seed, but the experience of others seems to contradict this. Dinwiddie[d] gives two months as the time required for a hog to be on cotton-seed meal before it can be regarded as immune.

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[a] Bul. No. 60, Mississippi Expt. Sta.; An. Rpts., 1900–01 and 1901–02, Oklahoma Expt. Sta.

[b] An. Rpt. 1901–02, Oklahoma Expt. Sta.

[c] Bul. No. 21, Texas Expt. Sta

[d] Bul. No. 76, Arkansas Expt. Sta.

The cause of poisoning not known.—The poisonous agent of cotton seed has not yet been determined. So far chemical and bacteriological examinations have revealed nothing to which can be attributed its dangerous character. The injurious action has been variously attributed to the lint on the seed, the large fat content, the highly nitrogenous composition, the sharpness of the hulls, the presence of a toxin, supposititious chemical or bacteriological changes in the meal, formation of poisonous crystals by metabolism, etc. Up to a certain period the amount of cotton seed or cotton-seed meal fed does not seem to have any influence on the health of the pigs, but the evidence on the subject is so meager that one is not justified in drawing conclusions as to the amount of meal that can be fed safely. Curtiss[a] inclines to the toxin theory; he found the amount which proved fatal in his investigation to be from 27 to 33 pounds of cotton-seed meal. Dinwiddie[b] holds that the belief that there is a toxic principle in the seeds of the cotton plant is the most reasonable one, and one that has not been disproved. The action seems to be more virulent with young than with older animals, which is characteristic of poisons. He points out that the amount fed to pigs is much larger in proportion to their body weight than that fed to cattle and suggests this as a reason for the supposed greater immunity of cattle. With a 1,000 pound steer, 4 pounds of cotton-seed meal is an amount equal to 0.4 per cent of the body weight. In the case of the pigs in the Arkansas experiments the proportion was about 1.5 per cent of the body weight at the beginning of feeding. The amount of cotton-seed meal eaten per head was 23, 25, and 45 pounds, respectively, in the three experiments at that station. Dinwiddie[c] calls attention to the fact that other animals are susceptible to cotton-seed poisoning and states that guinea pigs, to which he fed small quantities of cotton-seed meal along with bran, died in from two to three weeks. He also admits the possibility of ptomaine poisoning.

At the Alabama station two of Duggar's[c] experiments resulted fatally. In the first experiment the smaller pigs were the first to die. They averaged about 64 pounds, and 12.20 pounds of cotton-seed meal were eaten by each before death ensued. This was 0.25 pound daily per head, or 0.4 pound daily per 100 pounds live weight for forty days, and a total of 18.90 pounds per 100 pounds average live weight. Larger pigs in this experiment, averaging a little over 70 pounds, died when 16.60 pounds of cotton-seed meal had been fed per head. These pigs were fed 0.41 pound per head daily, or 0.53 pound per 100 pounds live weight daily, for forty-three days; the total amount of cotton-seed meal fed was 21.60 per cent of the average live weight. In the second fatal experiment one of the pigs died "after having appeared gaunt and weak for two days." This pig averaged about 60 pounds in weight and up to the time of death had been fed 5.4 pounds of cotton-seed meal. This was a total of 9.2 pounds per 100 pounds live weight. The pig had not had more than 0.25 pound cotton-seed meal daily per 100 pounds live weight. The other pig in the same lot showed an unthrifty condition and the ration was changed. (See the Kansas experience on page 122, where a similarly small amount of cotton-seed meal produced fatal results.) The ration in both experiments was, cotton-seed meal one-fifth, corn meal four-fifths.

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[a] Bul. No. 28, Iowa Expt. Sta.

[b] Bul. No. 122, Alabama Expt. Sta.

[c] Bul. No. 76, Arkansas Expt. Sta.

In another test with a ration of corn meal three-fourths, cotton-seed meal one-fourth, the pigs were noticed to be out of condition toward the thirty-fifth day, but no deaths occurred. They averaged about 118 pounds in weight, and the amount of cotton-seed meal which made them sick was 25.5 pounds. This was 21.4 pounds per 100 pounds live weight, or 0.61 pound daily per 100 pounds live weight.

The causes of death are regarded by Dinwiddie[a] as being both essential and contributory, the essential cause being the toxic principle supposed to be present. He describes the immediate cause of death as follows:

> In all our cases the immediate cause of death was obviously asphyxia, due to pressure on the lungs by the dropsical effusion into the pleural cavities. In its final manifestations the disease was an acute dropsy of the pleural and pericardial sacs. The congestion of the abdominal organs, and especially of the portal system, can be attributed to obstructed circulation through the collapsed lungs damming the blood back in the venous system, and hence a process secondary to the pleuritic effusion. That this portal engorgement was secondary to the pleural effusion, I infer from the absence of degenerative or other changes in the liver which could account for it and from absence of any marked peritoneal effusion. Ascites would be the first result of such extreme portal congestion if it were primary. All of these conditions, however, are necessarily the result of some fundamental cause, the nature of which is yet to be discovered. An acute hydrothorax and hydrops pericardii, unaccompanied by ascites and without any antecedent pleuritis, is a condition rarely met with in human pathology. Non-inflammatory dropsical effusion may be due to mechanical obstruction, cardiac disease, degenerative changes in the kidney or liver. or to physical or chemical changes in the blood itself. Neither of the first three causes appears to be in operation here. Further researches will probably show some grave alteration in the composition of the blood as the primary effect of acute cotton-seed meal poisoning. In hogs, at least, nervous derangements are not manifested, so far as I have seen.

Points that may in time lead to the discovery of the trouble are that old meal seems to be more fatal than fresh, that cotton-seed meal is more fatal than cotton seed in any condition, and that the poisonous agent is not in the oil, but seems to be entirely left in the cake when the oil is expressed. It is also well known throughout the South that decomposed cotton seed has little, if any, dangerous character, and it has been pretty clearly established by the studies of Curtiss[a] and by the experience of practical feeders that the meal is so changed by the processes of digestion that hogs following steers which are being fed a heavy cotton-seed meal ration are not injured by the droppings.

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[a] Bul. No. 76, Arkansas Expt. Sta.

Feeding value.—Disregarding, for the moment, the fatal effects of this product, let us consider its feeding value. The results from feeding either the whole grain or the meal have not been uniform, and have given rise to three opinions regarding its value as a pig feed—(1) that it is both worthless and dangerous; (2) that it is only fairly valuable and hardly worth the risk of feeding, and (3) that it is extremely valuable if means can be devised to feed it without fatal results.

The Kentucky Experiment Station[b] fed a ration of 1 part cotton-seed meal, 1 part wheat bran, and 2 parts corn-and-cob meal for twenty-eight days, when ship stuff replaced the cotton-seed meal, because the pigs refused it, whether fed wet or dry. No fatalities were reported, but the gains were unsatisfactory and the station came to the conclusion that, in Kentucky, "cotton-seed meal could not be fed profitably to hogs, whether for growth or fat."

Curtis[c] expresses himself in a similar tone, that, "After two years successive tests in feeding cotton seed and cotton-seed meal to hogs with a definite aim in view, and after practical attempts to use these products in a similar manner for the past ten years, we do not hesitate to express our candid opinion that there is no profit whatever in feeding cotton seed in any form or cotton-seed meal to hogs of any age; * * * that it is practically impossible to prepare cotton seed or cotton-seed meal in any manner so that hogs will eat it greedily."

Lloyd's[d] opinion, from his experience at the Mississippi Station, is somewhat similar. He had losses from raw cotton-seed meal, but none from those getting cooked seed, although these pigs became very sick and refused to eat. His gains were "neither satisfactory nor profitable." With one bunch of pigs the average daily gain was about 1 pound for the first two weeks, after which the gains were small, although the pigs did not lose their appetite and continued to eat with relish. The after effects of feeding in this case were detrimental, as the pigs never got into good condition.

At the North Carolina Station, Emery[e] fed an 88-pound pig for sixty-one consecutive days on a cotton-seed meal ration, the amount of cotton-seed meal varying from one-fourth pound daily at the beginning to 2 pounds daily at the close. Skim milk was fed during the first three weeks and green feed during the first six weeks. Two pounds of cotton-seed meal daily made the pig sick, and for twenty-two days the meal was dropped from the ration. Then the feed was made one-fourth cotton-seed meal, three-fourths wheat bran, with 12 pounds skim milk daily for ten days, after which corn meal was substituted for the cotton-seed meal. The feeding was unprofitable, but the pig did not die.

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[a] Bul. No. 28, Iowa Expt. Sta.

[b] Bul. No. 19.

[c] Bul. No. 21, Texas Expt. Sta.

[d] Bul. No. 60.

[e] Bul. No. 109.

Among the instances where feeding was fairly profitable, the results at the New York (State) Station[a] may be noted. The intention was not to note the effects of cotton-seed meal feeding. Cotton-seed meal in amounts varying from one-thirteenth to three-tenths of the entire ration was fed, with good results, covering periods of from fifty-six to one hundred and thirty-nine days. Two pigs in a lot fed on wet feed were troubled with indigestion, and after the close of the trial one of them died from "congestion of the liver, following indigestion." This may have been cotton-seed meal poisoning. The pigs were on a ration in which there was three-tenths pound daily for sixty-three days.

Cary's[b] results in Alabama are remarkable because of the large quantities of cotton seed fed. He conducted three experiments in which cotton seed or cotton-seed meal were fed to 13 pigs. From 1½ to 4½ pounds of crushed cotton seed were fed per head daily. In two instances cotton-seed meal was fed, but in small amounts (three-tenths pound daily in one case and three-fifths pound in the other). The pigs receiving cotton-seed meal did not thrive, losing appetite; one of them received bran, the other corn meal in addition to the cotton-seed meal, and both had green feed. When they were taken from cotton-seed meal and placed on corn and pasture they recovered rapidly.

In the first test the pigs on crushed cotton seed made fairly good gains. They had some grain in addition, and all received green or succulent feed. In the second test 3 pigs were fed rations of corn meal and crushed cotton seed or ground cowpeas and crushed cotton seed. The rations were heavy—6 pounds when corn meal was fed and 6½ pounds when cowpeas were fed; the amount of cotton seed was more than half the ration. Fair gains were made and the after effect does not seem to have been serious, as the pigs did well when placed on pasture and fed corn. One pig in this lot had crushed cotton seed alone, being fed 4½ pounds daily. He lost in weight, but gained in size of frame. When turned on pasture and given corn he did well. Another pig that had 3½ pounds crushed cotton seed and 3½ pounds green rye daily lost 28 pounds in twenty-eight days. After the rye was discontinued the pig failed to thrive, but recuperated rapidly on pasture with corn.

In three cases where 3 pounds of crushed cotton seed were fed daily, with ground cowpeas and green rye or corn meal and green rye, nominal gains were made. No disastrous effects followed when green feed was discontinued; subsequent treatment on pasture and corn gave good gains.

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[a] Eleventh and Twelfth An. Rpts.

[b] Bul. No. 68, Alabama Expt. Sta.

In a third test 2 pigs were fed for forty-nine days on a daily ration of 6 pounds of separator milk and 3½ pounds crushed cotton seed, then for fifty days on 6 pounds of whole milk and 3½ pounds crushed cotton seed. Their appetites failed twice, but they gained slightly in weight.

The length of time that cotton seed or cotton-seed meal was fed in these experiments was one hundred and five days in the first, ninety-one days in the second, and one hundred and nine days in the third. Although the pigs were occasionally off feed there were no fatalities.

Duggar's[a] experiments did not show very favorable results for cotton-seed meal as part of the pig's ration. In no case did the pigs so fed make so great an average daily gain as 1 pound, and the gains were usually expensive, whether the grain was fed alone or with green feed. Rations of corn meal only gave better results. One lot of 2 pigs, averaging 68 pounds, fed a ration of cotton-seed meal one-fifth, corn meal four-fifths, and grazed on sorghum, made an average daily gain of 0.53 pound for thirty-four days, at an outlay of 380 pounds of grain for 100 pounds gain. Another, averaging 68 pounds, on the same grain ration, but grazing peanuts, made an average daily gain for thirty-eight days of 0.94 pound, requiring 185 pounds grain for 100 pounds gain. Another lot made an average daily gain of 0.8 pound for twenty-eight days on a ration of cotton-seed meal one-fourth and corn meal three-fourths, requiring 384 pounds grain for 100 pounds gain, while a lot on corn meal only in the same test made an average daily gain of 1.1 pounds, but required 531 pounds grain for 100 pounds gain. Duggar found corn meal alone a more palatable ration than one to which cotton-seed meal had been added, and had difficulty in inducing pigs to eat a full allowance of a cotton-seed meal ration.

The Kentucky, Wisconsin, Iowa, Kansas, and Oklahoma experiment stations have published results that show cotton-seed meal to have considerable feeding value for pigs.

In Kentucky May[b] fed cotton-seed meal at intervals of one week as part of the ration to 20 grade Berkshire pigs during a three weeks' finishing period with very good results.

At the Wisconsin Station,[c] Henry fed two lots of 5 pigs each for thirty-five days on a ration of which one-half pound daily was cotton-seed meal. The feeding was alternated, one lot receiving oil meal while the other had cotton-seed meal. The rest of the grain ration was a mixture of equal parts of wheat shorts and corn meal. Skim milk and whey were fed, and the feeding was done in the fall and winter. The pigs were never sick nor off feed, and made their gains economically. The tabulation of results shows that while on cotton-seed meal the pigs required 5 per cent less feed than while on oil meal.

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[a] Bul. No. 122, Alabama Expt. Sta.

[b] Bul. No. 101, Kentucky Expt. Sta.

[c] Eleventh An. Rpt.

At the Iowa Experiment Station, Curtiss[a] fed two lots of 3 Poland China pigs each on a ration of corn-and-cob meal, cotton-seed meal, and buttermilk. One lot received one-half pound cotton-seed meal per head daily and the other 1 pound per head daily. The grain fed was soaked for twelve hours before feeding. Salt and ashes were also given. Everything went well until the sixth week, when the droppings of the pigs on the heavy ration became dark in color and somewhat hard. However, the appetite was not affected. The first pig died fifty-one days after feeding commenced, and a second went the day following. They had been on the heavy ration, but showed no signs of sickness, and their gains had been steady. Sixty-three days after the start a pig in the lot receiving one-half pound of cottonseed meal per head daily died, but not without symptoms of trouble. For a day or two before death he had shown a "failing appetite and quickened breathing." The rest of the pigs in this lot showed the same symptoms, but survived, although their gains were light. The Station veterinarian could find no assignable cause of death.

In this experiment the fatal quality of cotton-seed meal seemed to depend, to a certain extent, on the quantity fed. The first pigs to die were those in the lots receiving the heavier ration of cotton-seed meal. These pigs also made the better gains.

The Kansas Station[b] fed 4 small pigs a ration of one-sixth cotton-seed meal and five-sixths corn meal. The meal was stirred in water at feeding time. It was not relished at first, but when it was once eaten rapid gains were made. The first pig died twenty-three days after the feeding began, and "could not have eaten more than 5 pounds of cotton-seed meal altogether," a fact which seems to lessen the weight of the theory that the quantity eaten has an influence on the fatal property of the feed. This pig weighed about 18 pounds at the time of its death. The last pig died on the forty-sixth day of the experiment. (See Duggar's experiments, pp. 117, 118.)

Two sows weighing, respectively, 135 and 308 pounds were put on a ration of one-fourth cotton-seed meal and three-fourths corn meal for forty-five days; they gained 89 pounds each without signs of poisoning.

In a second test, 6 pigs that had been stunted by exclusive corn meal or ground wheat feeding were divided into two lots of 3 each and put on rations composed of one-fourth cotton-seed meal and three-fourths corn meal for one lot, and equal parts of these meals for the other lot. The change of condition is described as "magical" and immediate; the pigs began to gain in weight at once, and those receiving the greater amount of cotton-seed meal made the larger gains. No other feed was given. The first pig died on the forty-fifth day of the experiment, the second on the forty-eighth day, the third on the fifty-third day, and the fourth on the fifty-sixth day from the beginning of the cotton-seed meal feeding. Two pigs were left in each lot; they were placed on green oats and then thrived nicely.

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[a] Bul. No. 28.

[b] Bul. No. 53.

A later bulletin[a] from the Kansas Station mentions a lot of pigs that had done poorly in another experiment; they were fed cotton-seed meal, and were "ready for market, well finished, in twenty-two days." At the Kansas Station cotton-seed meal is very highly regarded to put pigs in high condition, if fed for a short time in small quantities. The beginning ration is one-fourth pound cotton-seed meal to each 1,000 pounds live weight per day, which is increased in ten days to make the amount 3 pounds per 1,000 pounds live weight.[b] The meal is mixed with the rest of the grain.

The Kansas and Iowa results show that a cotton-seed meal ration is valuable if the cotton-seed meal is used in a moderate amount and for a limited time. The proportions of cotton-seed meal used in the Iowa test were about one-eighteenth and one-ninth of the total grain rations at the start and about one-tenth and one-fifth at the close. Up to the time the pigs began to die the gains of those on the heavier cotton-seed meal ration were the larger and more economical (1.4 pounds average daily gain and 343 pounds meal and 250 pounds milk per 100 pounds gain). The lighter ration was about equal in results to one of corn-and-cob meal, gluten meal, and buttermilk, that stood second to the heavy cotton-seed meal ration. The two lots returned in pounds of gain per 100 pounds of dry matter in the feed (before deaths began) 31.1 pounds and 26.4 pounds, respectively, for the pigs on the heavy and the light rations. In the Kansas tests the gains before deaths commenced were also very economical; they varied in cost from considerably less than 300 pounds grain per 100 pounds gain in the case of the pigs that had been previously on the single-grain rations to 350 pounds grain per 100 pounds gain in the case of the sows.

Pigs following steers on cotton-seed meal.—Evidence of the dangerous properties of cotton-seed meal for pigs, when they are following steers whose ration is made up wholly or in part of cotton-seed meal, is conflicting. In the Iowa test[c] a lot of 3 pigs followed steers for seventeen weeks that were receiving from 4 to 7 pounds of cotton-seed meal daily. They had very little feed except what they picked up behind the steers, yet there were no noticeable injurious effects.

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[a] Bul. No. 95.

[b] This is about the ration furnished dairy cows in milk.

[c] Bul. No. 28, Iowa Expt. Sta.

The Kansas Station[a] states that the meal used in their early experiments was shipped in from Texas during the previous winter by a local feeder, to be fed to steers. He turned about 40 hogs after them, and all died in the course of six or seven weeks. Considerable evidence that pigs may not suffer after steers that are fed on cotton-seed meal has recently been presented in the columns of the agricultural press.

THE OKLAHOMA EXPERIMENTS.

The Oklahoma Station has made an extensive study of the possibility of feeding this by-product so that good returns may be obtained with little or no danger from poisoning. The conditions under which it has been found that cotton-seed meal may generally be fed safely are (1) where pigs have access to range and plenty of green pasture, and (2) where periods of cotton-seed meal feeding of three to four weeks' duration without pasture are alternated with a period on pasture or on a ration from which the cotton-seed meal has been omitted.

Following up this system the Oklahoma Station has conducted three experiments. In the first trial, in 1900, the alternating method was tried with 17 thrifty shoats of various sizes.[b] They were put on a ration composed of one-fifth cotton-seed meal and four-fifths Kafir-corn meal and had the run of a large paddock, where they got a little green stuff. The trial began March 22. For twenty-seven days the cotton-seed meal ration was fed; then for fourteen days Kafir-corn meal alone, next fourteen days on one-fifth cotton-seed meal, and four-fifths Kafir-corn meal, then seven days without the cotton-seed meal, closing with five days on the original ration. "None of the pigs had died, and all made very fair gains on a moderate amount of grain." At the close of this trial part of the pigs were sold and the rest continued on the cotton-seed meal ration, with which the trial closed (one-fifth cotton-seed meal and four-fifths Kafir-corn meal). They were fed on this ration without change until July 14 with the loss of 1 pig only.

In the second trial of the same year 16 stunted shoats, about a year old and averaging 79 pounds were used. For twenty-six days from April 12, they were hurdled on wheat and fed a light ration of one-fifth cotton-seed meal and four-fifths Kafir-corn meal. There was no ill effect from the grain ration. The gains averaged 0.96 pound per head daily and were made economically. On May 8 the pigs were taken from the wheat and fed the same grain ration in a lot for twenty-one days with no serious results, making an average daily gain of 1.71 pounds at the expense of 307 pounds of grain for 100 pounds gain. Five of the largest were sold after forty-seven days continuous feeding on a cotton-seed meal ration.

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[a] Bul. No. 53.

[b] An. Rpt., 1900–01.

The 11 pigs remaining were then given range and green feed and the same grain ration continued. The gains made were satisfactory. There were no losses, and they were sold on July 14, after ninety-three days' continuous feeding on a cotton-seed meal ration.

In 1901, 16 uniform Poland China shoats, farrowed late in the previous fall, were used.[a] They were about 11 weeks old at the beginning of the experiment and averaged about 47 pounds in weight. The experiment began January 11. The pigs were divided into four lots of 4 each. Each lot was given an open pen 9 by 24 feet, and had a space 8 by 8 feet in an inclosed piggery. Cob charcoal, wood ashes, and salt were always accessible; water only was given to drink, and the grain was mixed with water into the form of a thick slop just before feeding. From July 14 to April 1, 2 pounds of sugar beets were allowed each pig daily. The pigs were fed as follows: Lot I received corn meal only to April 5, then a mixture of one-fifth cotton-seed meal and four-fifths corn meal for four weeks, closing with two weeks on corn meal; Lot II received one-third corn meal and two-thirds wheat middlings; Lot III received one-fifth cotton-seed meal and four-fifths corn meal. Lot IV received one-fifth cotton-seed meal and four-fifths corn meal for four weeks, then corn meal for two weeks, next the cotton-seed meal mixture for four weeks, then back to corn meal only for two weeks, and alternating in this manner until the experiment closed.

The only signs of lack of appetite were in Lot I, where exclusive corn-meal feeding proved rather severe for such young pigs, and in Lot III, where a dullness of appetite was noticed for about two weeks. This was only temporary. One pig in Lot IV died on February 15, one week after it had been taken from the cotton-seed meal ration and placed on corn meal, and 2 pigs in Lot III died on February 20, after they had been on a cotton-seed meal ration continuously for forty days.[b] "No further losses occurred, * * * and the pigs thrived and made good gains." One pig in Lot IV showed symptons of sickness, but recovered.

After April 5, Lot I was given the same management and feed as Lot IV, but there were no injurious results. On the contrary, their gains increased. This was also noticed with Lot IV. During the periods that the hogs were on a straight corn-meal ration, except during the closing period, when their greater maturity enabled them to make use of a more carbonaceous ration, the gains were light and expensive, but when the cotton-seed mixture was resumed the gains were large and economical, disregarding the effect of loss by death.

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[a] An., Rpt., 1901-02.

[b] Dinwiddie had a similar experience. See Bul. No. 76, p. 147, Arkansas Expt. Sta.

The following table shows the results of the one hundred and twenty-six days feeding for the pigs that survived:

Feeding pigs on cotton-seed meal rations.

Ration.	Number of pigs.	Average weight at beginning, January 11.	Average weight at close, May 17.	Average gain.	Average daily gain.	Average amount grain eaten.	Grain per 100 pounds gain.	Cost of grain per 100 pounds gain.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*
Lot I:								
Corn meal	4	46	125	78	0.62	368	470	2.61
Lot II:								
Corn meal ½ Wheat middling ½	4	46	191	146	1.15	539	370	2.87
Lot III:								
Cotton-seed meal ⅕ Corn meal ⅘	2	47	182	135	1.07	483	357	2.24
Lot IV:								
Alternate rations	3	44	178	134	1.06	493	368	2.1

Burtis and Malone suggest that had the cotton-seed meal lots been running on green pasture from the beginning of the experiment no losses would have occurred. They also suggest the probability that a ration of one-tenth to one-fifth cotton-seed meal may be fed for an indefinite time if pigs have the run of green pasture.

THE ARKANSAS EXPERIMENTS.

In addition to throwing light on the pathological features of cotton-seed poisoning, Dinwiddie[a] has corroborated the results of those stations, which have shown that, when properly fed, cotton-seed meal is a valuable pig feed, if losses can be avoided. In the experiments in which all the pigs died, Lot I received a ration of cotton-seed meal 1 part and corn chops 3 parts; Lot II received cotton-seed meal 1 part, and corn meal 3 parts, with roots; Lot III received cotton-seed meal 1 part and wheat bran 3 parts, and Lot IV received bran 1 part and corn chops 3 parts. There were three pigs in each pen, and feeding began January 1, 1902. The pigs were confined in pens with an open shed for shelter, were watered and fed twice daily, and had a mixture of hard-wood ashes and salt supplied constantly. The results are tabulated as follows:

Feeding pigs on cotton-seed meal rations.

Lot.	Number of days until first death.	Eaten per head.	Eaten daily per head.	Eaten daily to initial weight.	Initial weight.	Daily gain per head	Daily gain to initial weight.
		Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*	*Per cent.*
Lot I	35	23	.68	1.6	41	0.9	2.2
Lot II	40	25	.64	1.5	42	1	2.4
Lot III	61	45	.80	1.6	48	1	2.1
Lot IV					47	.9	1.9

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[a] Bul. No. 76, Arkansas Expt. Sta.

Dinwiddie points out particularly that a corn-meal and cotton-seed-meal ration, which one would naturally select as giving the proper proportions between nitrogenous and carbohydrate constituents, proved the most fatal in his experiments, and that the bran and cotton-seed meal ration, the most nitrogenous of the three, required the most time for the dangerous property to assert itself. Contrary to what one would expect from the Oklahoma results, roots did not have so good an effect as the wheat bran.

The pigs received from 0.64 to 0.8 pound of cotton seed per head daily, which was from 1.5 to 1.6 per cent of their initial body weight. The first death occurred in the case of the pigs on corn and cotton-seed meal thirty-five days after the feeding commenced, an average of 23 pounds cotton-seed meal being eaten per head. In the case of the pigs fed corn, cotton-seed meal, and roots, the first death was forty days after the beginning, an average per head of 25 pounds of cotton-seed meal being eaten. The first death in the case of the pigs on bran and cotton-seed meal occurred sixty-one days after the beginning, 45 pounds of cotton-seed meal being eaten per head. Up to the time of death the gains of the pigs on cotton-seed meal were as good or better than those of the pigs on corn chops and bran (Lot IV).

Following the experiment in which all the pigs on cotton-seed meal died, Dinwiddie[a] fed 4 native pigs, averaging about 50 pounds in weight, on various rations, cotton-seed meal being a prominent factor, constituting one-fourth of the ration. Turnips were fed for eighty days, after which rye, oats, and alfalfa were given for two months. The pigs were fed from February 26 to November 6, 1902. Only 1 received cotton-seed meal throughout the experiment, and for a small part of the time none was given to it. The other pigs received rations of equal parts of bran and corn meal or ear corn after being taken from the cotton-seed-meal ration.

Dinwiddie presents the following tabulation of the results of this experiment:

Feeding pigs on cotton-seed meal rations.

Designation of pig.	Number of days fed cotton-seed meal.	Weight of cotton-seed meal eaten.	Weight of cotton-seed meal eaten daily in first period (80 days).	Daily consumption of cotton-seed meal to initial weight.	Weight of cotton-seed meal eaten daily in second period (59 days).	Weight of cotton-seed meal eaten daily for remainder of test.
		Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*
A	139	80	0.58	1.4	[a]0.55	
B	248	242	.58	1.4	.55	[b]1.5
C	198	137	.58	1.4	.55	[c]1
D	198	137	.58	1.4	.55	[c]1

[a] Decrease probably due to a larger supply of green feed.
[b] One hundred days. (Cotton-seed meal 1, corn meal 3.)
[c] Fifty-nine days.

A third test[a] was made in which rations of cotton-seed meal 1 part and bran 3 parts and cotton-seed meal 1 part and wheat chops 3 parts were fed. The former ration was fed for ninety-five days to 6 pigs, which averaged about 50 pounds in weight. The latter was given for ninety-nine days to 4 Tamworth pigs, averaging about 50 pounds in weight. The following table shows the results:

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[a] Bul. No. 76, Arkansas Expt. Sta.

Feeding pigs on cotton-seed-meal rations.

Ration.	Number of pigs.	Time fed cotton-seed meal.	Average amount cotton-seed meal eaten.	Average amount cotton-seed meal eaten during first month.	Cotton-seed meal to estimated initial body weight.	Average amount cotton-seed meal eaten daily after first month.	Cotton-seed meal eaten daily during test.
		Days.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*
Cotton-seed meal 1, bran 3	6	95	54	0.4	0.8	0.6	0.5
Cotton-seed meal 1, wheat chops 3	4	99	57	[a].4	18	[b].7	.5

[a] First half of period. [b] Last half of period.

There were no losses from these rations, and the pigs made small gains.

Effect of cotton-seed meal on pregnant sows.—Dinwiddie[a] fed a native sow carrying her third litter on a ration of cotton-seed meal 1 part and bran 3 parts for eighty days before farrowing. She ate a total amount of 112 pounds of cotton-seed meal, which was 1.39 pounds daily and 0.8 per cent of the estimated initial body weight. The ration agreed with her and there appeared to be no harmful effects on the fetal litter, it being farrowed safely, with no stillbirths.

Effect of crude cotton oil.—Dinwiddie[a] fed 3 pigs on a ration of corn meal 1 part, wheat bran 2 parts, and crude cotton oil 0.1 to 0.4 part. The amount of cotton oil fed (estimating the fat content of cotton-seed meal at 14 per cent) was equivalent to that contained in from 0.25 to 1.8 pounds of cotton-seed meal, the smaller amount having proved fatal in the Arkansas results, already discussed. These pigs were on the cotton-oil ration one hundred and forty-four days. The amount of oil fed for the entire time to each pig was 21 pounds, equivalent to 150 pounds of cotton-seed meal. The average daily amount of oil consumed varied from 0.06 pound (meal equivalent, 0.4 pound) to 0.24 pound (meal equivalent, 1.6 pounds). The average daily amount of oil fed for the entire test was 0.14 pound (meal equivalent, 1 pound). The pigs made an average daily gain of 0.6 pound, and suffered no serious effects from the oil.

Use of cotton-seed meal in the feed lot.—The use of cotton-seed meal in the feed lot must be very carefully guarded, especially until the conditions under which it may be used without danger and the circumstances which govern the demonstration of its poisonous properties are more thoroughly understood. The feeding of the cotton-seed meal which the South produces is one of the greatest problems of agriculture in that section yet to be solved satisfactorily. It is not difficult to appreciate what may be gained if some of this by-product, which has such high feeding and fertilizing value, and which is exported in such enormous quantities, can be converted into pork products, which are now largely imported from other States.

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[a] Bul. No. 76, Arkansas Expt. Sta.

PACKING-HOUSE PRODUCTS.

The frugality of the modern meat packer has become almost proverbial. Less than twenty years ago the disposal of the offal of slaughtering was a problem, but at present there is very little waste, and the packer has actually come to regard the by-products as the principal source of profit in his business. The preparation of these by-products for use as animal feed is one of the later developments of this branch of the industry. Fertilizers have long been prominent in the sales, the material that enters into their composition being meat scraps, blood, bone, hair, intestinal contents, etc. The use of tankage, a by-product that has had its sale entirely as a fertilizer, is growing among pig feeders, and has been studied by Plumb and Van Norman at the Indiana Station, and by Kennedy and Marshall at the Iowa Station. Beef meal is also a packing-house product, whose feeding value was studied along with that of tankage in the Iowa experiment.

Character of packing-house by-products.—Plumb and Van Norman[a] state that tankage may contain scraps of meat, intestines, and their contents, hair, etc. It is classed as *concentrated* and *crushed* tankage. Concentrated tankage is not used for animal food. Crushed tankage is said to be of several grades, being graded according to the ammonia and phosphoric-acid content, although it is probable that the tankage graded as No. 1 is free from the contents of intestines.

Kennedy and Marshall[b] used two brands of tankage made by Chicago packers. One of these is described as follows :

> Digester tankage is made from meat scraps, fat trimmings, and scrap bones. These are taken up as fast as taken from the animals and put into a large steel tank and cooked under a live steam pressure of 40 pounds to the square inch, which cooks out the tallow. After the steam is turned off it is allowed to settle, when the grease rises to the top and is drawn off. After the grease is drawn off the tankage is kept agitated, and by evaporation the water is extracted until the tankage contains about 8 per cent moisture. It is then taken out of the tank, allowed to cool, is ground, and stored ready for shipment. This tankage is supposed to contain about 60 per cent protein and 10 per cent fat.

The manufacture of the other tankage is thus described:

> This product, like the one just described, is made from meat scraps, scrap bones, etc. Quoting the words of the manufacturer, it is as follows: " Tankage is the product which drops to the bottom in our rendering tanks when we are rendering out grease, tallow, etc., at our various packing houses. It has been thoroughly cooked under 40 pounds pressure for several hours, which thoroughly destroys any disease germs which might possibly be in the raw meat. This product is

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[a] Bul. No. 90, Indiana Expt. Sta.

[b] Bul. No. 65, Iowa Expt. Sta.

pressed and then dried in steam driers at a high temperature. It is then ground and shipped in 100 and 200 pound sacks."

The beef meal, used in the Iowa[a] test, is described as follows:

> This product is made from scraps of meat and bone from which the grease has been extracted and the liquors concentrated by cooking. These are then pressed, dried, and ground in preparation for the market. It is claimed to contain from 40 per cent to 50 per cent of protein.

Analyses of packing house by-products.—The analysis of tankage reported by the Indiana Station is as follows:

	Per cent.
Moisture	8.63
Protein	49.81
Ether extract	15.78
Crude fiber	4.78
Nitrogen-free extract	5.06
Ash	15.94
	100

The Iowa Station analyses, including that of the corn meal used, are as follows:

Analyses of feeding stuffs. (*Weems.*)[a]

Ration.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn meal	11.05	1.55	15.25	4.85	63.80	3.50
Beef meal	6.10	15.60	61.10	5.20	3.12	8.88
Tankage	6.25	12.85	42.15	6.95	15.50	16.30
Do	9.05	20.65	39.10	10.90	8.60	11.70

[a] Bul. No. 65, Iowa Expt. Sta.

Feeding tankage in a corn-meal ration.—In the Indiana[b] experiment 16 young pigs were fed to determine the value of tankage. The pigs were purebred Poland Chinas and Berkshires. There were 4 lots, 2 of each breed in each lot. The tankage was specially prepared by the packers who furnished it to the experiment station, and was "made from bones and meat taken from the cutting room, tanked immediately, and pressed and dried."

The conditions of the experiment were equal for all lots; all had an opportunity for getting exercise and each lot was in a separate inclosure. There was no sickness and Lot III was the only one showing lack of appetite at any time. The pigs were fed as follows: Lot I, 10 parts corn meal and 1 part tankage; Lot II, 5 parts corn meal and 1 part tankage; Lot III, corn meal; Lot IV, 10 parts of a mixture of equal parts of corn meal and shorts and 1 part tankage. The feed was weighed out and then mixed with tepid water in the proportion of about 2 parts of water to 1 part of feed, a slop of medium thinness being made. Each lot of pigs had access to ashes and salt. The cost of feed used was as follows: Corn meal, $20 per ton; shorts, $16 per ton; tankage, $30 per ton.

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[a] Bul. No. 65, Iowa Expt. Sta.

[b] Bul. No. 90, Indiana Expt. Sta.

At the Iowa Station[a] five lots of 6 pigs each, averaging 205 pounds, were fed for forty-nine days, to note the value of packing-house products. "Each lot contained 3 crossbred Poland China-Yorkshires, 2 Poland China-Duroc Jerseys, and 1 Poland China-Berkshire." Corn was used as the basis of comparison and the pigs were fed as follows: Lot I received corn meal alone; Lot II received about 5 parts of corn meal and 1 part of beef meal;[b] Lot III received about 5 parts of corn meal and 1 part of digester tankage; Lot IV received about 5 parts of corn meal and 1 part of tankage.

The market prices of the corn meal and tankage are given as follows: Corn meal, $22 per ton; digester tankage, $32 per ton; tankage, $25 per ton.

The Iowa pigs were shipped to Chicago and the lots were sold separately. They brought $7.55, the extreme top of the market for the day of sale.

The following table shows the results of these experiments:

Tankage in a corn-meal ration for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.
						Grain.	Tankage.	Grain.	Tankage.	
Indiana:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dollars.*
Corn meal 10 Tankage 1	4	59	589	127	1.16	1,982	197	337	33	3.80
Corn meal 5 Tankage 1	4	58	625	127	1.23	1,984	379	317	61	4.00
Corn meal	4	58	342	127	.67	1,779	....	520	....	5.20
Corn meal and shorts 10 Tankage 1	4	58	579	127	1.14	2,001	199	346	34	3.60
Iowa:										
Corn meal	6	197	596	49	2.08	2,747	....	461	....	5.10
Corn meal and digester tankage	6	202	757	49	2.57	2,429	458	321	61	4.50
Corn meal Tankage	6	198	668	49	2.27	2,438	460	365	69	4.90

These experiments seem to show that tankage has a great deal of value for balancing a pig's ration.

In the Indiana test the use of tankage lessened the amount of grain required per 100 pounds gain from 203 pounds to 175 pounds—from 38.9 to 33.5 per cent—showing tankage to be very profitable with the prices that were charged for grain in this instance.

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[a] Bul. No. 65.

[b] One lot of pigs in this experiment were fed to note the value of condimental feeds. (See pp. 133, 134 for the results.)

In the Iowa test 140 pounds and 96 pounds, respectively, were saved by the use of tankage—30.4 and 20.8 per cent—not so good a record as obtained in Indiana. The difference between the money cost per 100 pounds of the corn-fed and tankage-fed lots was also much less than in Indiana.

The condition of the pigs in the Indiana test was remarked upon. The tankage-fed pigs handled better, had finer, silkier coats, and ate with much more relish than those on corn alone. The corn-fed lot was conspicuous by reason of its poor condition.

At the conclusion of their experiments, Plumb and Van Norman gave the pigs that had been on corn meal a ration of 5 parts of corn meal and 1 part tankage for forty-nine days. There was immediate improvement in their appetites, the hair softened, and the skin handled better. There was a marked improvement in growth, which contrasted strongly with the gains made while on corn meal only.

Experimenters caution stockmen to use that tankage only which has been specially prepared for feeding purposes.

Beef meal in a corn meal ration.—The results of the lot of pigs that were fed beef meal at the Iowa Station are compared below with those on corn meal. The price of the beef meal used in this test was $22 per ton.

Beef meal in a corn-meal ration for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.
						Grain.	Beef meal.	Grain.	Beef meal.	
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Corn meal	6	197	596	49	2.03	2,747	....	461	....	5.10
Corn meal 5 parts, beef meal 1 part.	6	197	707	49	2.40	2,448	458	346	65	4.80

Beef meal, like tankage, seems to be valuable in the pig's ration. The amount of grain saved per 100 pounds gain by the use of beef meal was 115 pounds, or 24.9 per cent.

SUGAR BY-PRODUCTS.

Feeding beet molasses.—Clinton[a] fed 5 pigs averaging 87 pounds on a ration of corn meal 8 pounds, beet molasses 12 pounds, and skim milk 20 pounds. "This quantity was given in two daily feeds, and the pigs apparently did not relish the molasses, yet they ate it." Three days after feeding commenced they ate the morning feed well, but within an hour 1 pig was dead and another died a few hours later. Postmortem examination indicated poisoning. The surviving pigs were then placed on a corn meal and milk ration, but made expensive gains, the cause assigned being the effect of molasses feeding.

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[a] Bul. No. 199, Cornell Univ. Expt. Sta.

This experiment had results similar to those of German investigators with beet molasses. It may be that this by-product is not a safe feed for pigs. However, other molasses by-products in sugar production, such as cane molasses, are valuable for feeding horses, cattle, and sheep, and many farmers value highly the "skimmings" from sorghum vats as a fattening feed for pigs. There are very few experimental data on the feeding value of the by-products from sugar refining.

CONDIMENTAL FEEDS.

Two experiments are noted which deal with the value of condimental stock feeds in pork production. These feeds have quite general use over the country, and, on account of strict legislative regulations and the supervision and analyses by the experiment stations, they are generally of high feeding value, having a high nutrient content. They are prepared with palatability in view and often contain some harmless drug that increases the attractiveness of the feed and may have a good effect on the digestive functions. They are thus frequently found valuable where animals are being crowded or are suffering from the effects of improper feeding. Oil meal usually forms the basis of these feeds and is supplemented by bran, bean meal, cotton-seed meal, ginger, fenugreek, etc. These feeds range in price per ton from $30 to $500. The manufacturers generally direct that they be used in very small amounts.

Feeding experiments.—At the Indiana Station Plumb[a] fed two lots of 4 pigs each to determine the value of American stock food. The pigs were gilts, four months old. There were 3 Poland Chinas and 1 Chester White in each lot. The experiment lasted one hundred and twenty-two days. Lot I was fed a mixture of equal parts of shorts and hominy feed and a small amount of American stock food; Lot II received the same ration without the stock food. At the Iowa Station Kennedy and Marshall[b] fed two lots of 5 crossbred pigs each averaging 205 pounds. One lot on corn meal and Standard stock food was compared with a lot on corn meal alone. The following are the results of the two tests:

Feeding pigs with and without stock food.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.	Profit per pig.
						Grain.	Stock food.	Grain.	Stock food.		
Indiana:	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Stock food	4	66	682	122	1.42	2,547	64	373	9.38	3.00	[c] 9.66
No stock food	4	65	689	122	1.43	2,581	......	375	......	2.60	[c] 13.94
Iowa:											
Stock food	5	197	655	49	2.23	2,858	14	436	2.14	5.00	2.64
No stock food	5	197	596	49	2.08	2,747	......	461	......	5.10	2.39

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[a] Bul. No. 93.

[b] Bul. No. 65.

[c] Profit per lot.

The Indiana results show that nothing was gained by the use of the prepared feed; in fact, there was indicated a decided disadvantage, as more feed was required per 100 pounds of gain and the profits were very much less than with the lot not having the prepared feed.

The Iowa results show a saving in cost of 10 cents per 100 pounds gain for the pigs receiving Standard stock food and a net profit per pig of 25 cents in favor of this lot as compared with pigs on corn meal alone. It is needless to point out that the results of these two experiments should not be too closely compared. In addition to the stock food given one lot, all the Indiana pigs were on a mixed ration; whereas in the Iowa test the stock food was the only variation from corn meal that was permitted. The results from adding any palatable feed to a straight corn-meal ration will be greater than the addition of the same or a similar feed to a mixed ration, because in the one case variety is the greatest necessity of the ration, while in the other it is already present. The same, if not very much better, results would have been seen had pigs on a ration of corn meal and green or succulent feed or dairy by-products been compared with pigs on a ration of corn meal only; and oil meal would probably have had a similar effect. While some of the difference in results may have been due to a difference in the quality of the two stock foods, it would naturally be expected that not only a better showing in rate and economy of gain for the stock food when conditions resemble those of the Iowa test would be made, but it would also be expected that there would be a relatively greater showing from the standpoint of total feed eaten. Both of these results are manifest; indeed, in the Indiana test the stock food seems to have had no effect whatever on the appetite.

Plumb[a] mentions a test by a student at Purdue University where Rauh's stock food was fed to 3 pigs for thirty-five days, after which they received Standard stock food for forty-nine days. They had equal parts of corn meal and shorts, and were compared with a lot of 3 pigs on corn meal and shorts only. There was a total gain of 2.5 pounds in favor of the prepared food first mentioned. The total balance was 21 pounds of gain in favor of the condimental feed. The results were as follows:

Feeding pigs with and without stock food.

Ration	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.	Total profit.
					Grain.	Stock food.	Grain.	Stock food.		
	Pounds.	*Pounds*		*Pounds.*	*Pounds.*	*Ounces.*	*Pounds.*	*Ounces.*	*Dollars.*	*Dollars.*
Stock food....	63	387	84	1.54	1,355	100	350	25.8	4.19	6.98
No stock food.	63	366	84	1.45	1,325	....	362	....	4.22	6.50

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[a] Bul. No. 93, Indiana Expt. Sta.

These results favor the stock food in about the same proportion as in the Iowa test.

DAIRY BY-PRODUCTS.

The use of the by-products of the dairy and creamery (skim milk, buttermilk, and whey) is one of the most interesting subjects of study in pork production. The value of the milk is known on every farm, although it may not be fully appreciated, and anyone who has fed pigs knows the keen appetite that these animals have for milk and its products. In the neighborhood of many large dairies pork production has become a very prominent and lucrative branch of the dairy industry.

Regarding solely their chemical composition, the by-products of the dairy contain most of the indispensable feeding constituents of the milk from which they are produced.

The residue from the separation of cream (skim milk) and that from churning (buttermilk) leave two products that contain practically all the protein and carbohydrates of the whole milk. In cheese making, the whey that is left is the least valuable of the dairy by-products, the greater part of the casein and fat of the milk being retained in the cheese. While whey is by no means worthless for feeding purposes, it can readily be seen that if skim milk and buttermilk have higher feeding values for pigs than whey, butter making and pig feeding will more profitably accompany each other than will cheese making and pig feeding. These by-products supply growing material to young animals and provide an excellent nitrogenous balance in the fattening ration. The constituents that remain in the milk after skimming and churning are the most expensive ones, considered from the standpoint of feeding and fertilizing value, and it is largely due to this fact that dairy farming is so often a profitable business when conducted in a thorough manner.

The value of dairy by-products is not alone in their nitrogenous character. They have an effect on the digestion that brings results out of all proportion to their nutritive value. Where pigs have been for a long time on a monotonous ration, such as corn meal alone, they lose appetite, become listless, and sick, and so make very unsatisfactory gains. If skim milk is given, even in very small amounts, an immediate change for the better is noticed—appetite returns and the pigs begin to gain rapidly in weight. As already stated, the gain in weight is out of all proportion to the actual amount of nutrient material in the milk, and this peculiarity has been remarked upon, not only when pigs are fed as indicated above, but also when pigs are fed a varied grain ration and skim milk in comparison with others on the grain ration only. Just why dairy by-products have this effect is not exactly known, but the suggestion has been made that they keep the digestive system in better order, and thus enable the animal actually to digest a greater percentage of his feed. The same fact has been noticed when roots and green feed are fed. Pasturing on rape, alfalfa, or the grasses probably has a similar effect.

The effect of dairy by-products on the carcass is one of the most important results of such feeding. It is generally admitted that, while excellent hams and bacon may be produced without dairy by-products, the use of these by-products will result in pork of a more nearly uniform high quality.

THE FEEDING VALUE OF DAIRY BY-PRODUCTS.

Comparing grain and milk rations with rations of grain alone and milk alone.—Linfield[a] reports the results of a series of investigations at the Utah Station. In all, seven distinct experiments are given. Except in one experiment, the pigs were confined on the north side of a barn, were furnished plenty of bedding, and allowed a small run. When grain alone was fed it was mixed with water to form a thin slop, and when milk was fed with grain it was mixed in the same manner. The milk was never given sour. The hogs had access to pure water, had charcoal and ashes in the pens, and were fed twice daily. These experiments were conducted primarily with the object of comparing the value of feeding a combination of grain and skim milk with both grain alone and skim milk alone. They varied somewhat in details, and some difficulty seems to have been experienced in obtaining as much milk as the circumstances required.

The grain was fed in various combinations with the milk, and was usually that which was available in that section for feeding purposes. It consisted of equal parts of barley and bran, corn and wheat, wheat and bran, and corn meal and bran, and in two experiments ground wheat. Whey was fed in the fifth, sixth, and seventh experiments; it formed not over 12 per cent of the by-product in the fifth, but was as much as 40 per cent in the last two. It was a matter of remark that the results in these experiments were fully equal to those where skim milk was fed throughout the entire feeding period, which shows that whey has quite a high feeding value.[b] The quantity of skim milk in the lots fed milk and grain in comparison with grain alone or milk alone varied from 4 to 6 pounds of milk per pound of grain fed at the beginning of the experiment, the amount of milk being gradually decreased with the age and weight of the pigs. The pigs used were well bred, usually being Berkshires, Berkshire grades, or Poland China grades. The following table is a summary of these experiments.

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[a] Bul. No. 57.

[b] See Ontario Agricultural College experiments with sweet and sour whey, pp. 147, 148.

Economy of skim-milk feeding.[a]

Ration.	Number of tests.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.
			Pounds.	*Pounds.*		*Pounds.*
Milk and grain	8	27	40	169	133	1.27
Grain	5	15	63	110	121	.91
Milk	4	11	39	74	108	.68

Ration.	Feed eaten per 100 pounds gain.		Dry matter per 100 pounds gain.	Digestible dry matter per 100 pounds gain.	100 pounds milk equal pounds gain.	Average amount feed eaten per day.	
	Grain.	Milk.				Grain.	Milk.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Milk and grain	292	768	334	258	23.2	3.73	9.74
Grain	470	....	421	319	....	4.41	....
Milk	....	3,312	298	285	14.2	....	22.28

[a] Bul. No. 57, Utah Expt. Sta.

These results indicate that, in rate of gain, an average of eight tests with a grain-and-milk ration shows gains made one-third faster than in five tests with grain alone, and nearly twice as rapidly as in four tests with milk alone. The least amount of dry matter required for 100 pounds of gain was that with the pigs on milk alone, but the pigs on grain and milk required the least digestible dry matter per 100 pounds gain. The returns from skim-milk feeding are estimated by Linfield at 17 cents per 100 pounds of skim milk when grain and milk were fed and 10 cents per 100 pounds of skim milk when milk alone was fed, grain being valued at 75 cents per 100 pounds.

These experiments show that pigs fed on grain and milk are enabled to eat much more feed than those on grain alone; those on grain and milk ate 4.24 pounds of dry matter per head daily; the pigs on grain alone 3.93 pounds of dry matter per head daily, and the daily average of the pigs on milk alone was only 2 pounds of dry matter. This is a point of great importance, and, with the figures showing rate and economy of gains, illustrates the fact that skim milk fed to pigs with grain enables them to eat more feed and to make more gain than pigs on grain alone.

The unsatisfactory character of the gains made by the pigs on skim milk alone is very apparent. This method of feeding should never be resorted to.

Corn and dairy by-products.—At the Tennessee Station Soule and Fain[a] fed four lots of pigs to compare a corn-meal and water ration with others, in which skim milk and whey were used. The pigs were high-grade Chester Whites and were confined in pens. The rations were as follows: Lot I was fed 6 pounds of corn meal and 10 pounds of water at the beginning of the experiment, increasing to 8 pounds of corn meal and 16 pounds of water toward the close. Lot II had 6 pounds of corn meal and 18 pounds of skim milk at the beginning, increasing to 8 pounds of corn meal and 40 pounds of skim milk toward the close. Lot III had 4 pounds of corn meal and 12 pounds of skim milk for the first fifteen days and 1.75 pounds of wheat meal, 6.25 pounds of corn meal, and 40 pounds of whey toward the close. Lot IV was fed 2.66 pounds of corn meal, 4 pounds of cowpea hay, and 8 pounds of skim milk at the beginning, which was changed to 5.5 pounds of corn meal, 1.5 pounds of chopped cowpea hay, and 26.75 pounds of skim milk toward the close.

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[a] Vol. XV, Bul. No. 1.

These rations were the amounts of feed that each lot received at a single feed, so that the daily ration for one lot of pigs was double the amounts given above. The feeds were valued as follows: Corn meal, $17 per ton; pea hay, $13.50 per ton; wheat meal, $25 per ton; skim milk, 22 cents per 100 pounds; whey, 11 cents per 100 pounds. The results were as follows:

Economy of skim-milk feeding.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Total dry matter eaten.	Dry matter per 100 pounds gain.
		Pounds.		*Pounds.*	*Pounds.*	*Pounds.*
Corn meal	3	186	60	1	775	416
Corn meal and skim milk	3	414	60	2.3	1,213	293
Mixed grain, skim milk, and whey	3	402	60	2.2	1,090	271
Corn meal, cowpea hay, and skim milk	2	246	60	2.0	1,017	414

Ration.	Total cost of feed.	Cost of feed per 100 pounds gain.	Net profit.[a]	Slaughter test.	
				Dressed weight.	Intestinal fat.
	Dollars.	*Dollars.*	*Dollars.*	*Per cent.*	*Pounds.*
Corn meal	7.39	3.90	7.69	73.6	13
Corn meal and skim milk	17.61	4.20	12.06	78.5	16
Mixed grain, skim milk, and whey	13.84	3.40	14.89	76.2	16
Corn meal, cowpea hay, and skim milk	12.97	5.20	4.12	77.7	9

[a] Value of manure and cost of care and feed considered.

The pigs were bought on the Knoxville market at 4½ cents per pound and weighed from 130 to 140 pounds at the time of purchase. They were sold at 5½ cents per pound.

The great advantages to be gained by feeding dairy by-products with carbonaceous concentrates are brought out in the results. The pigs on corn meal alone ate less than any others, and although their cost of feed was low they were not so profitable as those fed milk and grain, which ate very much more. An exception to the general rule is seen in Lot IV, which were fed very unprofitably.

With the pigs selling at 5½ cents per pound live weight, the authors estimate that this experiment returned, for the corn fed, 66.7 cents per bushel of 56 pounds, which is said to be 26.7 cents per bushel more than Tennessee farmers usually get for their corn. The feeding value of skim milk in this test was, approximately, 28.3 cents per 100 pounds

During the two years following the above experiment Soule and Fain[a] studied the value of skim milk in a corn-meal ration and in a mixed-meal ration. The pigs of the first year were of Chester White and Berkshire blood, some being Chester grades and others said to be Chester White-Berkshire crosses. They were above the average in quality. Those of the second year were Berkshire grades, below the average of the preceding year. The pigs were confined in pens and fed twice daily. Feeding was carried on through the winter. The first winter "was cool and bracing and uniformly dry;" the second "was raw and damp, with an excessive rainfall, and this no doubt had an influence on the general health of the hogs."

The lots which were used to compare a straight corn-meal ration with a corn-meal and skim-milk ration received, respectively, rations of corn meal only and corn meal and milk in the proportion of 1 to 8 by weight at the start, the milk being decreased toward the close so that the proportion of meal to milk was about 1 to 7.

Corn meal was charged at $28 per ton during the first year and at $19 per ton during the second year. Skim milk was charged at $4 per ton during both years.

The following table shows some of the results of this investigation. The findings of the two years were averaged, from which average these figures are taken:

Economy of skim-milk feeding.

Ration.	Number of pigs.	Total gain.	Average daily gain.	Total feed eaten.	
				Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Corn meal	7	119	0.50	489	....
Corn meal and skim milk	7	309	1.35	481	3,686

Ration.	Feed per 100 pounds gain.		Total cost of feed.	Cost of feed per 100 pounds gain.	Profit per group.[a]
	Grain.	Milk.			
	Pounds.	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*
Corn meal	410	....	5.75	5.80	1.05
Corn meal and skim milk	160	1,190	12.95	4.60	4.96

[a] Value of manure and cost of care not considered.

The favorable results from the feeding of skim milk with corn meal are very noticeable in these results. Although the addition of skim milk added to the cost of the total feed and the feed per 100 pounds gain was accordingly higher, the profit for the pigs on skim milk was $3.91 more than that of those on corn alone.

Value of skim milk in a mixed ration.—As part of the investigation of the years just mentioned, Soule and Fain[a] studied the value of skim milk in various proportions with a mixed ration of corn meal and wheat meal or corn meal and soy-bean meal. The proportions of these grains was 1 part of wheat or soy-bean meal to 2 parts of corn meal. The following prices per ton were charged for the feed:

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[a] Vol. XVI, Bul. No. 3, Tennessee Expt. Sta.

	First year.	Second year.
	Dollars.	*Dollars.*
Corn and wheat meal	29	22
Corn and soy-bean meal	33	25
Corn meal	28	19
Skim milk	4	4

The conditions were those described in the foregoing paragraph. The following table shows some of the results of the averages for the two years as published by the station:

Value of skim milk in a mixed-grain ration.

Ration.	Number of pigs.	Total gain.	Average daily gain.	Total feed eaten.	
				Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Grain 1 Milk 3	7	314	1.35	682	2,046
Grain 1 Milk 6	7	306	1.30	590	2,046
Grain 1 Milk 8	7	304	1.30	487	3,699
Grain 1 Milk 9	7	331	1.40	517	4,654
Grain 1 Milk 12	7	320	1.40	436	5,226
Grain 1 Milk 8 [a]	7	307	1.30	491	3,731

Ration.	Feed per 100 pounds gain.		Total cost of feed.	Cost of feed per 100 pounds gain.	Profit per group. [b]
	Grain.	Milk.			
	Pounds.	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*
Grain 1 Milk 3	220	650	12.46	4.40	7.63
Grain 1 Milk 6	190	1,160	14.35	5.10	5.27
Grain 1 Milk 8	160	1,220	13.54	4.80	4.13
Grain 1 Milk 9	160	1,410	15.67	5.10	5.62
Grain 1 Milk 12	140	1,640	15.83	5.30	4.77
Grain 1 Milk 8 [a]	160	1,220	14.49	5.10	3.38

[a] The grain to this lot was corn meal 2 parts, soy-bean meal 1 part. That to all the other lots was corn meal 2 parts, wheat meal 1 part.

[b] Value of manure and cost of care not considered.

The most economical ration is seen to be one in which the proportion of grain to skim milk was as 1 to 3. Beyond a certain point, it was found to be expensive to give the pigs a large amount of skim milk. However, all the lots receiving the dairy ration made good gains; the only one of the two years' tests which made an extremely poor showing was that on corn meal alone.

Skim milk compared with nitrogenous concentrates.—In order to compare the value of skim milk as a balance with that of a mixture of gluten and linseed meals Patterson[a] fed two lots of pigs of 6 each at the Maryland Station. Lot I received a ration as follows: Hominy chop, 300 pounds; ground corn fodder (new corn product), 100 pounds; skim milk, 2,400 pounds. Lot II received: Hominy chop, 300 pounds; ground corn fodder, 100 pounds; King gluten meal, 100 pounds; and linseed meal, 200 pounds. The grain was fed as a slop. Results were as follows:

Skim milk compared with nitrogenous concentrates.

Ration.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Feed eaten per 100 pounds gain.		Nutritive ratio.
					Grain and fodder.	Milk.	
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	
Grain, fodder, and milk	66	187	121	1.54	300	1,272	1:3.52
Grain and fodder	57	136	121	1.12	407	....	1:3.61

This experiment seems to bear out the contention that skim milk has more value as a feed than is indicated by the digestible nutrients it contains. The use of milk effected a saving of practically 25 per cent of grain in the feed required for 100 pounds of gain. The rations fed were identical in nutritive ratio, and they were made up of the same feeds, except that one was balanced with skim milk and the other with gluten and linseed meals. The great difference between the feeding values of the two rations must be ascribed to the effect of skim milk on the digestive system, and it would seem that a ration may be balanced in other ways than by the addition of certain proportions of nutrients with certain fuel values—a "balanced ration" being regarded as the one that gives the best results when fed for a certain purpose.

A comparison of skim milk and green clover in a pig's ration.—At the Maryland Station, Patterson,[a] fed two lots of Duroc Jersey and Berkshire grades of 6 pigs each on rations, one of which was balanced with skim milk and the other included cut green clover instead of milk. The grain was corn-and-cob meal, 8 parts, and 1 part each of gluten meal and linseed meal. The clover was given only in such amount as the pigs would eat. It was not possible to get them to eat enough to balance the ration completely. The feeding period lasted one hundred and sixty-five days.

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[a] Bul. No. 63.

Skim milk compared with green clover for pigs.

Ration.	Average weight at beginning.	Average gain.	Average daily gain.	Feed eaten per 100 pounds gain.			Digestible dry matter per 100 pounds gain.	Nutritive ratio.
				Grain.	Milk.	Clover.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Grain and skim milk	46.3	207.5	1.26	377	1,470	....	405	1:4
Grain and clover	47.1	99.30	.60	747	....	145	555	1:6.6

This experiment does not show profitable results from the feeding of green clover as compared with skim milk. The returns for the green clover are not at all satisfactory, very much less so than the results of other tests that have been made.

Corn meal and a mixture of corn meal and middlings in a skim-milk ration.—Clinton[a] reports the results of four years' experimenting at the Cornell University Experiment Station to study the value of certain proportions of skim milk to grain in the ration and the relative value of corn meal and a mixture of corn meal and wheat middlings in such a ration. In two experiments the best results were obtained when the ratios of grain to milk were as 1:3 and 1:2.5; in the other two the best results were with a ration in which the ratios of grain to milk were as 1:6.7 and 1:6.2. There were 133 hogs fed in these tests. The following table has been compiled from the results, and shows the feed required for 100 pounds gain for the two feeds:

Economy of skim-milk feeding.

Ration.	Number of tests.	Number of pigs.	Feed required for 100 pounds gain.	
			Grain.	Milk.
			Pounds.	*Pounds.*
Corn meal and milk	17	81	273	1,016
Corn meal, middlings, and milk[a]	12	52	223	1,069

[a] The proportion of these feeds was 4:1 in three tests. In the fourth it was not stated.

Grain values of skim milk.—The following figures show the grain values of skim milk as obtained under various methods of feeding at Ottawa.[b] The results are combined in the following table:

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[a] Bul. No. 199.

[b] Bul. No. 33, Central Experimental Farm.

Grain values of skim milk.

Number of pigs.	Skim milk consumed per head daily.	Milk value of 100 pounds grain.	Kind of grain.	Grain value of 100 pounds milk.
	Pounds.	*Pounds.*		*Pounds.*
4	2	183	Corn	54.64
7	3	183	do	54.64
8	3	354	Barley	28.24
31	3	323	Mixed grain	30.96
4	5.4	538	do	18.69
4	5.41	534	do	18.72
4	13.6	791	Frosted wheat	12.64
5	15.7	699	Mixed grain	14.30
5	15.7	734	do	13.62
2	17.1	882	do	11.33
2	17.14	882	do	11.33
2	23.7	776	do	12.88
4	32.41	834	do	11.99
Average		604		16.55

The average of results obtained by Danish experimenters is a value of about 600 pounds of milk for 100 pounds of grain, but the greater amount of work of this nature in America has shown a higher value for skim milk. The average of nineteen trials in Wisconsin with proportions of milk ranging from 1 to 9 pounds for each pound of grain fed, with hogs of all ages, was that 475 pounds of skim milk were equal to 100 pounds of meal.[a] In Utah[b] Linfield found the value of 100 pounds of milk in terms of grain (that is, the amount of grain replaced by 100 pounds of milk) to be 23.2 and 26.3 pounds, respectively, in two series of experiments. Grisdale[c] values milk at from one-fifth to one-sixth as much as mixed grain. In all experiments the large return where the proportion of milk to grain is small is particularly noteworthy. Milk should never be given to pigs in unlimited amounts except while with the sow, or immediately after weaning, up to the weights of 75 or 100 pounds. At this early age, much grain will disarrange the digestion and best results can be expected from a ration that is largely milk.

Grain required for 100 pounds gain when feeding skim milk and grain as compared with grain alone and milk alone.—The following table is adapted from one compiled by Linfield[d] from the results of various stations for the purpose of showing the cost in grain of feeding rations of grain and skim milk, grain alone, and skim milk alone.

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[a] Henry: Feeds and Feeding, p. 572.

[b] Bul. No. 57.

[c] Bul. No. 33, Central Experimental Farm.

[d] Bul. No. 57, Utah Expt. Sta.

Feed per 100 pounds gain.

Station.	Dry matter for 100 pounds gain.		
	Grain and milk.	Grain alone.	Milk alone.
	Pounds.	*Pounds.*	*Pounds.*
Wisconsin	345	455	180
Colorado	298	576	
New Hampshire[a]	281	334	
Utah[a]	334	421	298
	258	319	285

[a] The results in New Hampshire and the second line of Utah results show estimated digestible dry matter.

These figures show what can be regarded as representative values of these three methods of feeding, and emphatically demonstrate the economy of the grain-and-milk combination. Linfield calls attention to the fact that none of the pigs fed milk alone attained a weight of over 100 pounds, whereas some of those in the other columns reached nearly 300 pounds. It does not always mean profitable feeding for a hog to require a small amount of feed to make a certain gain.

Value of milk at various prices for grain.—Using as a basis the results obtained in the investigations already mentioned, Linfield[a] makes the following estimates of the value of skim milk as a supplementary feed in a ration at various prices for grain:

Value of skim milk for pigs.

Ration.	Number of pigs.	Grain equal to 100 pounds skim milk.	Value of skim milk per 100 pounds when grain is worth, per 100 pounds—						
			40 cents.	50 cents.	60 cents.	70 cents.	80 cents.	90 cents.	$1.
		Pounds.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Milk and grain.	27	23.2	9.3	11.5	13.9	16.2	18.6	20.9	23.2
Milk	11	14.2	5.7	7.1	8.5	9.9	11.4	12.8	14.2

A similar study was made by Lindsey[b] and others from the results at the Hatch Station, except that the figures do not include the results of feeding on milk alone. The averages of their experiments are given in the following table. "Starchy feeds" refer to such substitutes for corn meal as hominy meal, cerealine feed, rye meal, wheat meal, etc.; "other grains" are the nitrogenous feeds, such as wheat bran, gluten meal, linseed meal, etc.:

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[a] Bul. No. 57, Utah Expt. Sta.

[b] Eleventh An. Rpt., Hatch Expt. Sta.

Value of skim milk for pigs.

Cost of feed—	With dressed pork at 5 cents per lb., skim milk is worth—		With dressed pork at 6 cents per lb., skim milk is worth—		With dressed pork at 7 cents per lb., skim milk is worth—	
	Per quart.	Per 100 pounds.	Per quart.	Per 100 pounds.	Per quart.	Per 100 pounds.
	Cent.	*Cents.*	*Cent.*	*Cents.*	*Cent.*	*Cents.*
With corn meal and other starchy feeds at $15 per ton, "other grains" at $17.50 per ton	0.50	23.07	0.67	30.73	0.83	38.19
With corn meal and other starchy feeds at $17.50 per ton, "other grains" at $20 per ton	.45	20.66	.61	28.14	.78	35.86
With corn meal and other starchy feeds at $20 per ton, "other grains" at $22.50 per ton	.39	18.08	.56	25.82	.78	35.70

Cost of feed when feeding skim milk.—The following shows the cost of feed per 100 pounds of live and dressed weight produced as estimated from the Massachusetts[a] experiments at various prices for grain and milk :

Cost of feed per 100 pounds of growth produced.

Cost of feed—	Cost per 100 pounds live weight.	Cost per 100 pounds dressed weight.
	Dollars.	*Dollars.*
With corn meal at $15 per ton, "other grains" at $17.50 per ton, and milk at ¼ cent per quart	2.78	3.47
With corn meal at $15 per ton, "other grains" at $17.50 per ton, and milk at ½ cent per quart	4.00	4.99
With corn meal at $17.50 per ton, "other grains" at $20 per ton, and milk at ¼ cent per quart	3.04	3.79
With corn meal at $17.50 per ton, "other grains" at $20 per ton, and milk at ½ cent per quart	4.25	5.31
With corn meal at $20 per ton, "other grains" at $22.50 per ton, and milk at cent per quart	3.63	4.53
With corn meal at $20 per ton, "other grains" at $22.50 per ton, and milk at ½ cent per quart	4.51	5.63

The labor cost of feeding.—In experiments in pork production investigators almost invariably disregard the expense of care and labor, estimating that this will be covered by the value of the manure made and the saving in expense of marketing crops. This is always more or less of an obstacle in applying the results of experiments to actual farming conditions, for the manure is not always carefully saved on the farm. Linfield,[a] of the Utah Station, studied the labor cost as shown by the experience of some of the creameries in his State that were feeding large numbers of hogs, and states the result of his inquiries as follows:

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[a] Eleventh An. Rpt., Hatch Expt. Sta.

> One creamery reports that one man would feed 1,000 hogs, clean all the pens each day, and draw the grain feed from the mill 2 miles distant. Another says that one man does all the work of feeding and cleaning out the pens for 500 hogs in five hours each day. The wages paid in each case was about $1 per day.
>
> At both creameries the hogs are purchased when weighing from 50 to 100 pounds each, though some few are heavier. The hogs are crowded from the start, and at most not more than 100 days are required to fit the hogs for market, and in this time 100 to 125 pounds have been added to the live weight of each hog.
>
> By putting all of the above figures together we find that it costs five hours' labor or 50 cents to look after 500 hogs for one day, or $50 to look after 500 hogs for one hundred days. This is 10 cents for 1 hog for one hundred days, or for 100 pounds gain, which gives one-tenth of a cent as the labor cost of producing 1 pound of live weight of hog. It is thus evident from the results of these practical men that when handled in large numbers, as hogs may be at a creamery, the labor is a very small item in growing the hogs. If the value of the gain was reckoned at 4 cents per pound the labor cost of producing the pork was but 2½ per cent of its selling price.

Lest these results be misleading, Linfield calls attention to the fact that the conditions were almost ideal for the greatest economy, the hogs were "short fed," and all feeding appliances and pens were so arranged as to have in view the greatest possible saving of labor. At another creamery, where the hogs were raised on the place and fed until they were fifteen months old and the accommodations were not so good, the cost reported was as large for 300 hogs as the others reported for 1,000 head. It is pointed out that, on the average farm, where the number of animals is much smaller, and milk must usually be hauled back to the farm, the labor cost will be very much greater.

Skim-milk rations for growing pigs.—The Hatch Station[b] recommends the following rations for pigs weighing from 20 to 180 pounds when the feeder has an unlimited supply of skim milk at hand:

Rations for growing pigs.

Weight of pigs.	Rations.
20 to 60 pounds	3 ounces of corn meal to each quart of milk.
60 to 100 pounds	6 ounces of corn meal to each quart of milk.
100 to 180 pounds	8 ounces of corn meal to each quart of milk.

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[a] Bul. No. 57.

[b] Eleventh An. Rpt.

The following rations may be used where the milk supply is in limited amounts:

Rations for growing pigs.

Weight of pigs.	Rations.
20 to 180 pounds	3 ounces of corn meal, wheat, rye, or hominy meals to each quart of milk, and then gradually increase meal to satisfy appetites.
20 to 60 pounds	Milk at disposal, plus mixture of one-third corn meal, one-third wheat bran, and one-third gluten meal to satisfy appetites.
60 to 100 pounds	Milk at disposal, plus mixture of one-half corn meal, one-fourth wheat bran, and one-fourth gluten meal to satisfy appetites.
100 to 180 pounds	Milk at disposal, plus mixture of two-thirds corn meal, one-sixth wheat bran, and one-sixth gluten meal to satisfy appetites.
20 to 60 pounds	3 ounces of corn meal to each quart of milk, and 4 ounces of gluten feed as a substitute for quart of milk.
60 to 100 pounds	Milk at disposal, and mixture of one-half corn meal and one-half gluten feed to satisfy appetites.
100 to 180 pounds	Milk at disposal, and mixture of two-thirds corn meal and one-third gluten feed to satisfy appetites.

Sweet compared with sour whey.—At the Ontario Agricultural College, Day[a] conducted five experiments to compare the feeding values of sweet and sour whey. Each experiment was preceded by a preliminary period of from one to two weeks and the experiments proper varied in duration from twenty-nine to sixty-four days. In each one as a check a group of pigs was fed on meal only mixed with water. The group receiving whey had it mixed with the grain, and both lots received the same quantity of whey, which was about 2 pounds to each pound of meal. All lots had as much feed as they would eat readily. The sour whey fed in 1897 "was kept in a tank which had not been cleaned since early in the summer of 1896." The meal was a mixture of equal parts of pease, barley, and oats.

The following table shows the amount of grain saved by feeding whey for each experiment and for the average:

Grain saved by feeding sweet and sour whey.

Experiment.	Amount of meal saved by 100 pounds of sweet whey.	Amount of meal saved by 100 pounds of sour whey.
	Pounds.	*Pounds.*
No. 1 (1896)	13.82	13.61
No. 2 (1896)	13.32	13.81
No. 3 (1897)	14.88	7.87
No. 4 (1897)	No test.	10.07
No. 5 (1897)	6.08	9.34
Average	11.90	10.94

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[a] An. Rpts., 1896 and 1897.

Whey feeding is often attended with difficulty, as it causes a stiffening of the joints and serious lameness. This condition occurred in the experiments of 1896; and in 1897 the group fed sweet whey in experiment No. 4 was so seriously checked by this trouble that they were left out of the comparison. Day calls particular attention to the fact that the lots receiving sour whey were not at all affected.

If experiment No. 4 is omitted in the preceding table, the average amount of meal saved by 100 pounds of sour whey is 11.15 pounds. The value of whey in pork feeding is, according to these figures, about half that of skim milk.

The following shows the results of six analyses of whey made during these experiments by the chemical department of the Ontario Agricultural College:

Composition of whey.

	Sweet whey.	Sour whey.
	Per cent.	*Per cent.*
Nitrogenous matter	0.920	0.973
Sugar	4.709	.081

Day suggests that the higher percentage of nitrogenous substances in the sour whey was perhaps due to evaporation of the original samples.

PASTURE AND PASTURE SUBSTITUTES.

PASTURE.

Value of pasture with a grain ration.—The Utah Station[a] has devoted considerable study to the effect and value of pasture for pigs that are on a grain ration. The pastures used were made up of mixed grasses and alfalfa. The Utah problem in pork production is defined as the use of "a minimum amount of grain and a maximum amount of alfalfa, milk, and whey, or other cheap foods." The following table shows the results of four seasons' study of this problem, where rations of grain and pasture and grain alone were compared:

Value of pasture with grain.

Ration.	Feed eaten daily.	Total gain.	Average daily gain.	Feed eaten per 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Grain and pasture	4.72	247	1.21	385
Grain	4.05	185	.94	430

These results strongly favor the use of pasture when feeding pigs under conditions similar to those that exist in Utah. In every respect the pigs on pasture show better results than those that had no pasture; the total gain per head averaged 33 per cent greater for the pigs on pasture than for those on grain alone; the average daily gains were nearly 29 per cent greater, and there was a saving of more than 10 per cent in the feed per 100 pounds gain for the pigs on pasture.

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[a] Bul. No. 70.

Value of a grain ration with pasture.—The converse of the Utah experiments is shown by two experiments by Morrow and Bone[a] in Oklahoma.

Two lots of 4 pigs each were placed in half-acre alfalfa lots, one being given a full feed of grain and the other receiving none. In eight weeks the lot without grain had gained only 68 pounds, or 17 pounds each, and those having grain gained 324 pounds, or 81 pounds each.

A sow with a litter of 5 pigs was in the same lot with the grain-fed pigs. The sow gained 61 pounds in thirty-five days, when she was removed. Her 5 pigs made a total gain of 146 pounds in the first five weeks and 96 pounds during the succeeding period of three weeks. The grain fed these pigs amounted to only 221 pounds per 100 pounds gain.

Pasture in addition to dairy by-products.—Four tests were made in Utah[b] to determine the value of pasturing pigs that are receiving a ration of grain, milk, and whey. One test was made with pasturing pigs that were receiving milk and whey, but no grain. The ratio of milk to grain by weight was 5:1 at the start and 3:1 at the close in the second and third tests. In the fourth test the grain was limited to one-half the quantity fed the other lots, but all the milk and whey was given that the pigs would take.

The pigs that received the grain and dairy by-product ration were fed in pens.

The following table shows the results for each test and the average of all:

Value of pasture with dairy by-products.

Ration.	Total gain.	Average daily gain.	Feed eaten daily.		Feed per 100 pounds gain.	
			Milk.	Grain.	Milk.	Grain.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Milk[a] and pasture	218	0.69	21.00	....	3,034	....
Milk	202	.64	23.54	....	3,672	....
Milk, grain, and pasture	350	1.11	9.56	3.34	859	300
Milk and grain	366	1.16	10.71	3.13	921	269
Milk, grain, and pasture	324	1.25	10.11	3.38	805	269
Milk and grain	351	1.35	11.52	3.24	879	238
Milk, grain, and pasture	273	1.05	15.65	1.09	1,479	139
Milk and grain	284	1.10	18.12	1.62	1,837	147
Average with pasture	291	1.03	14.08	2.60	1,544	236
Average without pasture	301	1.06	15.97	2.66	1,827	218

[a] By "milk" is meant both milk and whey.

The results of the first test bear out previous experience with attempts to make pork on pasture without grain, although the gains given are fairly good and better than might be expected on a pasture containing only a small amount of alfalfa. The addition of skim milk did not prove beneficial in anyway. In the experiments where grain was fed no advantage accrued through the use of pasture, except that the pasture lots consumed nearly 300 pounds less milk per 100 pounds gain than those in pens. At 15 cents per 100 pounds, this means a difference of 45 cents per 100 pounds of pork made. The difference in grain fed was nearly 20 pounds per 100 pounds of pork made in favor of the pen-fed lots.

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[a] An. Rpt. 1898–99, Oklahoma Expt. Sta. [b] Bul. No. 70, Utah Expt. Sta.

These results are evidence in support of the idea that the effect of dairy by-products and succulent feed in the ration is similar, and that to get the greatest amount of gain at the least expenditure of feed only one of the supplementary feeds is necessary; that the addition of pasture to a ration which already contains a large amount of dairy by-products is superfluous; and that the only advantage to be gained by such a method of feeding is the exercise obtained by the pigs on pasture.

Pen compared with pasture feeding.—At the Utah Station, Linfield[a] fed six lots of 3 pigs each, in two tests, to study the value of rations composed of grain and milk, grain alone, and milk alone. Both tests were conducted during the summer and fall of the same year. In one test the pigs had the run of a pasture of mixed grasses in which was a large amount of alfalfa. The following table shows a comparison between pen and pasture feeding:

Pen compared with pasture feeding.

Method of feeding.	Average daily gain.	Dry matter per 100 pounds gain.	Estimated digestible dry matter per 100 pounds gain.	Dry matter eaten per day.
Lots fed on milk:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
On pasture	0.7	256	261	1.79
In pen	.65	310	275	2
Lots fed on milk and grain:				
On pasture	1.12	319	261	3.58
In pen	1.17	320	262	3.78
Lots fed on grain:				
On pasture	.81	355	268	4.35
In pen	.51	443	334	2.28

The only pigs that showed better results in pens than on pasture were those on grain and milk. Those receiving grain alone on pasture gave very much larger gains, required less feed per 100 pounds gain, and ate more feed than those receiving grain alone in pens. Linfield suggests that either the exercise or the feed obtained by the run on pasture gave these pigs greater appetite and enabled them to digest a greater amount of feed daily. The fact that neither of the other lots showed a marked advantage from pasture might be explained by the skim milk in the ration. It is perhaps a safe proposition that in feeding pigs the best results will follow the use of dairy by-products, roots, or pasture, in connection with grain, but that it is superfluous to combine two of these supplementary feeds, as their action on the digestive system seems to be similar. When attempts are being made to prevent disease, however, the advantage of ample exercise must not be overlooked.

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[a] Bul. No. 57.

Corn compared with wheat on alfalfa pasture.—At the Nebraska Station,[a] Burnett and Smith placed three lots of 6 pigs each on alfalfa pasture lots one-fourth acre in area. The pigs were Tamworth-Duroc Jersey crossbreds. Lot I was fed ground corn; Lot II, a ration composed of 95 per cent ground corn and 5 per cent dried blood, and Lot III received ground wheat. In addition to the pasture, all the pigs had one week on rape. The experiment lasted forty-two days. The results follow:

Corn compared with wheat on alfalfa pasture.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average gain.	Average daily gain.	Average amount feed eaten.	Feed per 100 pounds gain.	Cost per 100 pounds gain.	Profit per lot.[a]
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Ground corn	6	146	223	77	1.22	308	400	4.00	3.77
Ground corn 95 per cent. Dried blood 5 per cent	6	145	227	82	1.30	308	376	4.04	3.88
Ground wheat	6	147	229	82	1.30	308	376	4.13	3.83

[a] Expense of pasture and labor considered.

The cost of feed in this experiment was, for corn, $1 per hundredweight; wheat, $1.10 per hundredweight, and dried blood, $2.50 per hundredweight. The results are so close together that a slight change in the prices of feed would change the relative rank of these rations. The value of pasture is apparent when these results are compared with those of the experiment at this station with wheat and other grains. (See p. 98.)

Maintaining pigs on pasture alone.—At the Utah Station Foster and Merrill[b] conducted two tests to observe the effect of maintaining pigs on pasture alone.

According to Henry,[c] no station has shown that pigs can be successfully maintained on pasture alone if the test reported from the Utah Station is excepted. The further investigations at this station on this line are therefore of much interest.

In 1898 a comparison was made of mixed pasture and alfalfa pasture. The pigs were about five months old at the beginning of the test, had been fed grain and milk, and were in a very thrifty condition. Both lots had access to running water.

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[a] Bul. No. 75. [b] Bul. No. 70. [c] Feeds and Feeding, pp. 578, 579.

The experiment in 1899 was in some ways a continuation of that of 1898. Two lots of pigs were used; both were on alfalfa pasture, but they differed in age. Lot I consisted of 3 pigs about four months old, and Lot II of 3 pigs about seven months old and nearly twice as heavy as those in Lot I. The following table gives the results of the experiments:

Pigs on pasture without grain or milk.

Ration.	Number of pigs.	Total weight at beginning.	Total weight at close.	Total gain.	Number of days fed.	Average daily gain.
1898.		*Pounds.*	*Pounds.*	*Pounds.*		*Pound.*
Lot I. Mixed pasture	....	251	321	70	125	0.189
Lot II. Alfalfa pasture	....	284	280	[a]4	109	.0122
1899.						
Lot I. Alfalfa pasture	3	165	188	23	129	.059
Lot II. Alfalfa pasture	3	330	322	[a]8	110	.024

[a] Loss.

These experiments do not change one's opinion regarding the value of pasture alone for pigs. The two lots gained in weight—one on mixed pasture and the other on alfalfa pasture. The effect of this method of feeding on the appearance of the pigs was very marked; in the 1898 test this was particularly commented upon. "The plump rounded forms gave place to large coarse frames and large stomachs. At the end of the experiment they looked very much larger than at the beginning, but the scales failed to show any gains. What is said above would also apply to the mixed pasture set, only in that case the eye was not so badly deceived—small gains were made."

In 1899 pigs that were receiving small amounts of feed, either milk or grain in addition to pasture, were found to have made gains very nearly in proportion to the amount of extra feed given, which Foster and Merrill regard as evidence that the pasture supplied enough feed for maintenance only.

GREEN SUBSTITUTES FOR PASTURE.

Pasturing on rape.—At the Utah Station Foster and Merrill[a] pastured 6 pigs on a plot of rape that had been seeded August 11, after having been irrigated and plowed. The pigs were hurdled in pens 16 feet square and without shelter from rain or snow. They received a ration of 1 pound daily of a mixture of equal parts of bran and chopped wheat.

At the Canada Central Experimental Farm, Grisdale[b] pastured 6 pigs on a plot three-sixteenths acre in extent that had been drilled to rape, the drills being 30 inches apart. These pigs received a daily grain ration of 1 pound per head at the beginning, which was increased to 5 pounds at the close. At the Alabama Station, Duggar[a] hurdled pigs, which had been weaned three weeks, on rape drilled on sandy upland the previous October. They received about a half ration of corn meal in addition.

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[a] Bul. No. 70.

[b] An. Rpt., 1900.

The results are as follows:

Pasturing on rape.

Where fed.	Number of pigs.	Total weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Grain eaten.	Grain per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Utah	6	296	60	49	0.204	294	490
Canada	6	358	869	114	1.27	2,067	238
Alabama	4	130	181	81	.56	524	290

At the close of the Alabama test, the pigs were placed on second-growth rape for three weeks. They grazed one-sixth acre, eating 168 pounds corn meal and making a gain of 82 pounds, which was an average daily gain of 0.98 pound, at a cost of 205 pounds meal for 100 pounds gain. Assuming that 500 pounds of grain alone are required for 100 pounds gain, Duggar[a] estimates the amount of the pork produced per acre from the first and second growth rape together at 512 pounds, worth at that time $20.48.

Seven shoats, averaging 41 pounds in weight, were on rape at the same station for four weeks during the late spring. They received some corn meal in addition. During the first two weeks the rape was fed to the pigs in the pens; during the remainder of the time they were hurdled. They ate 318 pounds of corn meal. The total gain in weight for the four weeks was 103 pounds, an average daily gain of 0.53 pound, 310 pounds of grain and 4,050 square feet of rape being required to produce 100 pounds of gain.

Rape compared with clover.—The Wisconsin Station[b] has reported two experiments comparing rape and clover as pasturage for hogs. In the first, 20 purebred or high-grade Poland China pigs between five and six months of age were used. Lot I was hurdled on rape, had access to water, and had the run of a blue-grass lot. Their grain feed was a mixture of 2 parts of corn meal and 1 part shorts twice daily as slop. Lot II was on a 10-acre lot of second-growth clover, and received the same grain ration as Lot I. In the second experiment the pigs used were purebred and high-grade Berkshires and Poland Chinas. Their grain ration was the same mixture as that used in the first experiment, mixed into a thick slop. Lot I was hurdled on rape; Lot II had the run of an 8-acre field of second-growth clover. The results were as follows:

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[a] Bul. No. 122.

[b] Sixteenth and Seventeenth An. Rpts.

Rape compared with clover.

Ration.	Number of pigs.	Total weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Grain eaten.	Grain per 100 pounds of gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Grain and rape	20	2,111	1,043	63	0.87	4,083.75	392
Grain and rape	21	2,139	1,492	56	1.27	4,965	333
Average							362
Grain and clover	20	2,091	941	63	.78	4,083.75	434
Grain and clover	21	2,136	1,435	56	1.22	4,965	346
Average							390

These experiments give rape a greater value for pigs than clover pasture. Rape has an advantage of over 7 per cent in grain required per 100 pounds of gain.

The influence of rape on grain eaten.—At the Wisconsin Station Carlyle[a] fed two lots of pigs—one lot hurdled on rape pasture and the other fed in a roomy yard without any kind of green feed. Both lots received the same grain ration, which was a mixture of equal parts of corn meal and shorts made into a slop immediately before feeding, and had coal ashes at all times. The experiment began August 4, when the rape was about 20 inches high. The pigs used were about four months old at the beginning of the experiment, and represented the Poland China, Berkshire, and Yorkshire breeds. The following is a summary of the results:

Value of rape with grain.

Ration.	Total weight at beginning.	Total weight at close.	Grain eaten.	Total gain.	Average gain.	Average daily gain first six weeks.	Average daily gain second six weeks.	Grain per 100 pounds gain.	Cost of grain per 100 pounds
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pound.*	*Pounds.*	*Pounds.*	*Dollars.*
Lot I, without rape	1,017	2,211	5,642	1,194	70.2	0.71	1.08	487	3.78
Lot II, with rape	1,001	2,412	5,920	1,411	83	.88	1.23	420	3.36

Exclusive rape feeding.—At the Wisconsin Station Carlyle[b] fed two lots of pigs on rape alone for two weeks. Two lots of 18 pigs each were taken from rations composed of grain exclusively, grain and clover, and grain and rape. They were given nothing but rape. They fed nearly all day, appeared contented, and scoured but little, but 25 of the 36 lost in weight during the two weeks. They were on rape, and only 4 made gains. The total loss on 36 pigs was 60 pounds, or at the rate of 1⅔ pounds per pig. The 6 pigs that had been on an exclusive grain diet lost 18 pounds, or 3 pounds each. The 8 pigs that had been on grain and clover lost 19 pounds, an average of nearly 2½ pounds each, and the 22 pigs that were taken from a grain and rape diet lost 33 pounds, or 1½ pounds each.

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[a] Eighteenth An. Rpt.

[b] Seventeenth An. Rpt.

Soiling.—The Utah Station[a] reports the results of seven tests of the value of green feed to pigs in pens and yards on full grain and one-fourth grain rations. In four tests the pigs were in pens and in three they were in open yards. The green feed was mainly alfalfa, but some waste garden products were also fed.

During the first two years of these tests, embracing four experiments, the dry matter in the grass was estimated and included in the figures for feed eaten; but in the last three tests only the actual weight of grain fed was taken into account. The following table shows a summary of the results:

Value of soiling pigs on grass.

Ration.	Number of tests.	Average daily gain.	Feed eaten daily.	Feed per 100 pounds gain.
Average of all:		*Pounds.*	*Pounds.*	*Pounds.*
Full grain	7	1.04	4.42	424
Full grain and grass	7	1.13	4.74	414
One-fourth grain and grass	3	.36	2.23	659
Average of pens:				
Full grain	4	.94	4.05	442
Full grain and grass	4	1.17	4.75	408

These results show a considerable advantage in daily gains for the pigs that were soiled and a similar saving in feed. The pigs in pens show a very marked advantage for soiling. There was an average daily gain of 0.23 pound more for the soiled pigs than for those on grain alone, and the feed required for 100 pounds gain was nearly 10 per cent less. It is suggested that these good results were due as much to the healthful action of such feed on the digestive system as to their nutrient content.

The Ontario Agricultural College[b] conducted an experiment to compare pasturing on such feeds as vetches and rape with their feeding in pens. Disregarding the item of labor, these results show that soiling is very economical. The average daily consumption of feed by pigs in the pens was approximately 4 pounds of green feed and

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[a] Bul. No. 70. See page 93 for explanation of "partial" and "full" grain rations.

[b] An. Rpt., 1901.

4½ pounds of meal. This experiment was part of a breed test, and generally the best pigs were in the outside lots. Yet the meal required for 100 pounds gain was, for all breeds, 510 pounds with the outside lots and 414 for those in the pens on grain and green feed. At the close of the experiment the pigs were sold, and the packer's report showed nothing unfavorable to the method of feeding. The bacon produced was firm and of good quality in other ways. The pigs that were soiled required twice as much time for attention and feeding as those outside.

Purslane.—Plumb[a] reports a trial in Indiana with two Chester White sows confined in small pens and fed for twenty-one days a mixture of equal parts shorts and hominy meal with all the purslane they would eat. Purslane was not eaten with the relish that was expected, but the pigs made fairly good gains at a cost of 2.2 cents per pound.

Grazing chufas.—Duggar[b] hurdled 9 Berkshire pigs from November 19 to December 17 on chufas, with some grain, and a mixture of corn meal and cowpea meal in addition. They gained 121 pounds, grazed 7,986 square feet of chufas, and ate 262 pounds of grain, thus requiring only 234 pounds of grain for 100 pounds gain. With the usual allowances for the gain due to the grain fed, the return per acre for the chufas, estimating pork at 3½ cents per pound, was $13.09.

Grazing peanuts, chufas, and soy beans.—At the Arkansas Station, Bennett[c] fed four lots of half-bred Berkshire pigs to compare the grazing values of these three crops with pen feeding on corn. The soil on which the crops were grown was a sandy loam with an estimated capacity of 30 bushels of corn per acre. The crops named were planted in rows 3 feet apart—the peanuts 14 inches apart in the rows, the chufas[d] 12 inches apart in the rows, and the soy beans drilled. The stand was estimated at 87 per cent for the peanuts, 75 per cent for the chufas, and only good for the soy beans. The corn was fed dry on the ear, and the grazing was done by using hurdles. The feeding lasted forty-six days, except for the soy beans, which gave out sooner than expected. The results were as follows:

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[a] Bul. No. 82.

[b] Bul. No. 122, Alabama Expt. Sta.

[c] Bul. No. 54.

[d] Chufas are coarse plants belonging to the sedge family. Two species are used in the manner here mentioned—*Cyperus rotundus* and *C. esculentus*. According to Gray, *C. rotundus* is found in sandy fields from Virginia to Florida and Texas, and is occasionally met with in the neighborhood of Philadelphia and New York City. *C. esculentus* is found in low grounds, along rivers, etc., from New Brunswick to Florida and west to Minnesota and Texas. This is the species more commonly used as feed for hogs.

These plants form small tubers which enable them to spread rapidly and form a thick, matted growth, each tuber being capable of producing a plant. The tubers are relished by hogs, but the plants are of questionable value, as it is almost impossible to eradicate them when once established, especially in sandy soils. Botanists do not advise planting them in soil that can be used for any other purpose.

Peanuts, chufas, and soy beans compared with corn.

Kind of feed.	Number of pigs.	Average weight at beginning.	Total gain.	Average daily gain.
		Pounds.	*Pounds.*	*Pound.*
Peanuts	4	116.5	104.5	0.57
Chufas	4	121.3	66	.35
Soy beans	3	124.75	[a] 22.75	[a] .24
Corn	3	139	112.3	.81

[a] Thirty-two days.

The areas of peanuts and chufas grazed were one-twelfth acre and one-ninth acre, respectively. To produce 112.3 pounds of pork with the corn-fed lot 7.6 bushels of corn were eaten. From these data the yield of pork per acre was estimated as follows:[a] Peanuts, 1,252 pounds; chufas, 592 pounds; corn, 436 pounds, estimating the corn yield at 30 bushels per acre.

The quality of the pork from pigs grazed on chufas and soy beans was about the same as that from corn-fed pigs; the peanut-fed lot produced a soft, oily quality of fat, but no deleterious results could be detected in cooking.

In the following two years Bennett[b] grazed pigs on peanuts and chufas, the results being noted below. In addition to the study of the feeding value of these plants, their effect on the quality of the pork was studied. When hogs are grazed on peanuts or chufas the lard has quite a low melting point; and, as nearly all such feeding is conducted in the Southern States, this condition gives rise to considerable trouble during the summer months. To obviate this difficulty the common practice of farmers is to use corn in finishing hogs that have had peanuts as the principal component of the ration. The results of the study of the effects of these feeds on the quality of pork are presented elsewhere in this bulletin.

Bennett's feeding results in 1899 and 1900 follow:

In 1899 Lot I grazed a crop that was alternately three rows of peanuts and one of chufas; Lot II grazed peanuts; Lot III grazed chufas; Lot IV grazed chufas; Lot V grazed as Lot I. The grazing lasted sixty days, except for Lots IV and V, which grazed ninety days. Lots III, IV, and V had no finishing period on corn. Two pigs were slaughtered in both of the first two lots at the expiration of the grazing period, the melting point of the fat determined, and the remaining pigs put on a full feed of corn. At intervals of two weeks 2 more pigs were slaughtered and the melting point of the fat determined, continuing in this manner until all the pigs were slaughtered, so that the last pigs to be slaughtered had been on corn eight weeks.

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[a] Soy beans not estimated.

[b] Bul. No. 65, Arkansas Expt. Sta.

The pigs used in the 1899 experiment were natives, not over one-fourth of improved blood. They were from ten to twenty months old and averaged about 115 pounds in weight.

In 1900 the feeding was as follows: Lot I grazed on a field of alternate rows of peanuts and chufas for seventy-five days, receiving some corn in addition. Lot II grazed a field of alternate rows of peanuts and chufas for fifty days, and for twenty-five days received a quantity of corn equivalent to that fed the above lot. Lot III grazed peanuts for seventy-five days and had corn as Lot I. Lot IV grazed peanuts as above for fifty days and had corn for twenty-five days as the preceding lots. Lot V grazed on peanuts and had corn at the same time for seventy-five days. The pigs of this lot were purebred Berkshires, and were used to determine the effect of improved blood on the melting point of lard.

The quality of these pigs was somewhat higher than in the experiment of 1899. The pigs of Lots I to IV were from eight to twelve months old at the beginning; the purebred pigs were from six to eight months old.

The gains of the pigs, while incidental to the main purpose of the experiment, are of much interest. Those for 1899 are as follows:

Comparative gains in feeding pigs on peanuts, chufas, and corn.

Lot.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.
		Pounds.	*Pounds.*		*Pounds.*
I	10	116.7	981	60	1.63
II	10	116.2	996	60	1.66
III	4	111.5	332	60	1.38
IV	2	115.5	246	90	1.37
V	2	116.5	266	90	1.47

The following gains were made during 1900:

Comparative gains in feeding pigs on peanuts, chufas, and corn.

Lot.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.
		Pounds.	*Pounds.*		*Pounds.*
I	4	99.5	518	75	1.72
II	4	95	482	75	1.60
III	4	96.25	535	75	1.78
IV	4	95	510	75	1.70
V	6	96	717	75	1.59

Grazing peanuts.—At the Alabama Station, Duggar[a] grazed 6 Poland China pigs on peanuts, with some corn in addition. The lot made a gain of 380.7 pounds in six weeks on an area of about one-sixth acre and ate 373 pounds of corn. Estimating corn at 40 cents per bushel and pork at 3 cents per pound this is a return of $18.34 per acre for peanuts from this method of feeding, somewhat less than the Arkansas experiment previously mentioned.

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[a] Bul. No. 93.

On a portion of the field which was not pastured the peanuts were dug and yielded at the rate of 62.6 bushels (1,565 pounds) of dry nuts per acre. From this the total feed required to produce 100 pounds gain was estimated as 140 pounds of peanuts and 190 pounds of corn—a total of 330 pounds of concentrates, with vines eaten not estimated.

Duggar estimates the value of the return from peanuts in pork at $18 per acre, and states that the same land with the same fertilizers, would not produce over 200 pounds of lint cotton per acre, which would be worth $10 or $12, with cotton at 5 or 6 cents per pound, while the expense of cultivating the cotton would be much greater.

In a later experiment Duggar[a] penned a litter of 9-weeks-old pigs on a two-thirds stand of Spanish peanuts just after weaning. They were on this pasture from November 4 to December 23, and ate 162 pounds of corn meal for 100 pounds gain in addition to grazing about five-sixths of an acre of peanuts. At 4 cents per pound for pork, and making allowances for the grain eaten, the return per acre for the peanuts was $10.04.

In another test[a] a sow and her litter of 9 pigs were fed from September 30 to November 4 on corn meal, skim milk, and Spanish peanuts from one-fourth acre of land. They ate 355 pounds of corn meal and 921 pounds of skim milk. The sow and pigs gained a total of 236 pounds. At 4 cents per pound for pork, valuing corn meal at $1 per 100 pounds and skim milk at 25 cents per 100 pounds and estimating 325 pounds of skim milk to be worth 100 pounds corn meal, the return per acre for the peanuts was $17.28.

In another test[a] 7 shoats, averaging nearly 100 pounds, were penned on Spanish peanuts from October 11 to November 2 and fed some corn meal. They made a total gain of 225 pounds, eating 286 pounds of corn meal and grazing the peanuts on 0.47 acre, requiring only 127 pounds of corn meal for 100 pounds gain. With the usual allowances, the return per acre for the peanuts in this test was $18.02.

In another test[a] 7 shoats were taken from corn meal, cowpea meal, and sorghum and placed on Spanish peanuts and corn meal for four weeks. They ate 333 pounds of corn meal and grazed 10,593 square feet of peanuts, making a gain of 121 pounds, which was at a cost of 273 pounds grain for 100 pounds gain. The value per acre of the peanut pasture was estimated, by the usual method, at $9.

Some of these pigs were continued by hurdling on peanut pasture and were given some grain in addition for five weeks longer. In this period the return per acre for the peanuts was estimated at $9.88.

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[a] Bul. No. 122, Alabama Expt. Sta.

In another test[a] a litter of 7 Poland China pigs, averaging 28 pounds in weight, were hurdled on Spanish peanuts just after weaning. The pasturing continued six weeks and no grain was fed. The total gain was 157 pounds, an average daily gain of 0.53 pound. The area grazed was 13,887 square feet, and the return per acre, with pork at 4 cents per pound, was $20.12.

Peanut pasture compared with corn meal.—The Alabama Station[a] fed one lot of pigs on a peanut field which was a poor stand, giving some corn meal additional; another lot had nothing but the peanut pasture, and a third lot corn meal only. There were 3 pigs in each lot, and they were of rather ordinary feeding qualities. In four weeks the lot on peanuts and corn meal gained 38.6 pounds, those on peanuts alone gained 21.1 pounds, and those on corn meal lost 5.1 pounds. The lot on peanuts and corn meal ate 206 pounds of corn per 100 pounds gain and grazed 2,025 square feet planted in peanuts. "This is at the rate of 840 pounds of growth from 1 acre of peanuts (with less than half a stand) and 1,710 pounds (35.6 bushels) of corn meal. With pork at 3 cents per pound and corn meal at 40 cents per bushel of 48 pounds, this is a gross return of $25.20 and a net return (after subtracting the value of the meal) of $10.94 per acre of peanuts."

The pigs on peanuts only "pastured an area of 3,517 square feet, and the gain made was 21.1 pounds, which is at the rate of 261 pounds of pork per acre. At 3 cents per pound gross for pork, this gives a value of $7.83 to the acre of peanuts on which there was only half a stand of plants."

Duggar estimates the value of peanuts in pork production at $12 to $20 per acre, the higher returns being made where corn meal supplements the peanut pasture.

Peanuts and chufas compared with grain.—Duggar[b] fed four lots of 3 pigs each for eighteen days to compare the values of peanut and chufa pasture with grain alone. Lot I grazed Spanish peanuts and had a half ration of a mixture, by weight, of corn meal 2 parts and cowpea meal 1 part; Lot II grazed Spanish peanuts without grain; Lot III grazed chufas, with the same half grain ration as Lot I; Lot IV was fed in a bare lot and given all the mixture fed Lot I that the pigs would eat up clean. The following table shows the results:

Peanut and chufa pasture compared with grain.

Area grazed and ration.	Average weight at beginning.	Number of pigs.	Number of days fed.	Total gain.	Average daily gain.
	Pounds.			*Pounds.*	*Pounds.*
Spanish peanuts grazed, one-half grain ration.	121	3	18	81	1.50
Spanish peanuts grazed	85	3	18	22	.41
Chufas grazed, one-half grain ration	106	8	18	79	1.46
Full grain ration	131	3	18	71	1.31

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[a] Bul. No. 93, Alabama Expt. Sta.
[b] Bul. No. 122, Alabama Expt. Sta.

Peanut and chufa pasture compared with grain.—Continued.

Area grazed and ration.	Total feed eaten.		Grain per 100 pounds gain.	Pasturage on 1 acre for a 100-pound shoat.
	Area grazed.	Grain eaten.		
	Sq. feet.	*Pounds.*	*Pounds.*	*Days.*
Spanish peanuts grazed, one-half grain ration	8,344	152	188	850
Spanish peanuts grazed	12,448			463
Chufas grazed, one-half grain ration	7,937	152	192	827
Full grain ration		304	431	

This experiment shows the best returns when grain was fed with these crops. Grazing peanuts alone was very unsatisfactory. The return per acre of peanuts and chufas, with pork at 4 cents per pound, was estimated, where grain was fed, at $9.56 and $9.62, respectively. The pigs on peanut pasture alone returned only $3.03 per acre for the crop. Those on pasture with grain made much more rapid and economical gains than those on grain only.

The last column of the table is especially interesting. With a small amount of grain it is evident that pasture will be available for a much longer period than when no grain is fed.

Grazing sorghum and cowpeas.—Duggar[a] fed four lots of 3 pigs each for five weeks to compare the value of sorghum and cowpea pasture with a grain ration. Lot I was hurdled on drilled sorghum which was in the dough and ripening stages and received a half grain ration of a mixture, by weight, of corn meal 2 parts and cowpea meal 1 part. Lot II was placed in a pen in which sorghum was growing and had, in addition, enough ripe Spanish peanuts to constitute a half ration of peanuts. Lot III was hurdled on drilled Whip-poor-will cowpeas on which part of the pods were ripe and received no grain. Lot IV was confined in a bare pen and given the grain mixture given Lot I in such amount as the pigs would eat up clean. The following table shows the results:

Grazing pigs on sorghum and cowpeas.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Grain per 100 pounds gain.
						Area grazed.	Grain eaten.	
		Pounds.	*Pounds.*		*Pounds.*	*Sq. feet.*	*Pounds.*	*Pounds.*
Grain Grazed sorghum	3	59	75	35	0.71	4,872	244	328
Spanish peanuts Grazed sorghum	3	59	54	35	.51	4,872		
Grazed ripe cowpeas	3	57	51	35	.48	17,964		
Grain	3	64	124	35	1.18		464	374

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[a] Bul. No. 122. Alabama Expt. Sta.

These results are not very satisfactory for grazing on sorghum or on cowpeas without a supplementary grain ration. The waste of feed in the cowpea lot was very great, large numbers of the ripe pease falling to the ground and sprouting. Previous work at the Alabama Station has shown more satisfactory results when grain was fed in conjunction with the cowpea pasture.

Duggar[a] notes another experiment with sorghum grazing, in which there was a large waste of feed, although grain was fed. Seven shoats were on the sorghum from June 24 to September 2, 1899, and received at the same time about 1½ pounds per head daily of a mixture of equal parts, by weight, of cowpea meal and corn meal. The pigs grazed 15,374 square feet of sorghum and 8,380 square feet of second-growth sorghum. They ate 812 pounds of grain, or 360 pounds of grain per 100 pounds of gain. Making allowances for the value of the grain fed, the return per acre of sorghum, with pork at 4 cents per pound, was estimated at $7.80. The second-growth sorghum produced only about one-half as much feed as the first growth. Large quantities of the sorghum were trampled under foot, and when some of it was cut and carried to the pigs a given area lasted much longer than when they were turned in to graze. Duggar suggests that when labor is cheap and abundant or a corn harvester is available soiling sorghum will be the more profitable method of feeding.

Cowpea pasture with corn.—Duggar[b] fed 6 Essex shoats from the same litter to investigate the pasture value of cowpeas. Lot I received corn only. Lot II was hurdled on cowpeas that were about half matured at the beginning of the experiment. The field tested 13.2 bushels per acre of peas, on an unpastured portion. Both lots received hard-wood ashes and salt. The results were as follows:

Cowpea pasture and corn compared with corn alone.

Kind of feed.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Corn eaten.	Corn per 100 pounds gain.
		Pounds.	*Pounds.*		*Pound.*	*Pounds.*	*Pounds.*
Corn alone	3	50.9	45.2	42	0.36	263.8	586
Cowpea pasture and corn	3	49.4	122.0	42	.97	374.0	307

The pigs were pastured on an area of 7,280 square feet, or about one-sixth of an acre. Valuing pork at 3 cents per pound and corn at 40 cents per bushel, the return for cowpeas per acre is $10.65, not including the value of the manure made. By pasturing, 277 pounds of corn were saved per 100 pounds gain, and therefore an acre of cowpeas would replace 1,662 pounds of corn, using this test as a basis.

The Maryland Station[c] fed a number of pigs on cowpea pasture and concluded that cowpeas are well adapted to pigs about three months old. The older pigs that had been highly fed and had always been kept in a pen evidently had lost their rustling ability and did not thrive so well on cowpeas.

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[a] Bul. No. 122, Alabama Expt. Sta. [b] Bul. No. 93, Alabama Expt. Sta. [c] Bul. No. 63.

PUMPKINS AND APPLES.

Feeding pumpkins raw and cooked.—At Ottawa, Grisdale[a] fed pumpkins to pigs in considerable numbers. A field was specially prepared, the seed being planted in hills 8 feet apart each way. The yield was about 9 tons per acre and the cost 90 cents per ton. In feeding one lot received raw pumpkins and grain (a meal mixture of one-half corn meal and one-half a mixture of equal parts of oats, peas, and barley). The other lot received cooked pumpkins and the same meal mixture.

At the Oregon Station, French[b] took 6 Berkshires, eight months old, from a stubble field where they had been for six weeks and placed them on a ration of pumpkins and shorts. The pumpkins were the common yellow field variety, and were prepared by cutting up, removing the seed, and cooking or steaming, after which shorts were mixed with them.

At the New Hampshire Station, Burkett[c] fed pigs to compare cooked and raw pumpkins. Lot I, consisting of 3 pigs, received skim milk, corn meal, and cooked pumpkins; Lot II, consisting of 3 pigs, received milk, corn meal, and raw pumpkins. The following table shows the result of these experiments:

Value of pumpkins as feed for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.			Cost per 100 lbs. gain.
						Grain.	Milk.	Pumpkins.	Grain.	Milk.	Pumpkins.	
Ottawa:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Raw pumpkins	......	......	745	107	......	1,981	......	2,090	267	......	281	3.08
Cooked pumpkins	......	......	706	99	......	1,602	......	7,500	227	......	1,062	2.96
Oregon:												
Cooked pumpkins	6	171.5	499	......	1.49	924	......	7,523	185	......	1,508	2.99
New Hampshire:												
Raw pumpkins	3	142	170	25	2.26	514	630	1,348	302	370	793	3.31
Cooked pumpkins	3	138.6	166	25	2.21	514	630	742	309	379	447	3.32

Averaging these results, the raw pumpkins rations show 273 pounds of grain and 376 pounds of pumpkins for each 100 pounds of gain, and the cooked pumpkins rations, 222 pounds of grain and 1,150 pounds of pumpkins for each 100 pounds of gain.

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[a] An. Rpt., 1900, Central Experimental Farm.

[b] Bul. No. 54.

[c] Bul. No. 66.

Raw pumpkins alone.—Burkett[a] fed one lot of hogs on a ration of uncooked pumpkins with no other feed but skim milk with the following results:

Pigs ... number	3
Average weight at beginning ... pounds	141
Total gain ... do	84
Days fed ... number	25
Average daily gain ... pounds	1.12
Milk consumed ... do	630

Pumpkins ... pounds	3,798
Milk per 100 pounds gain ... do	750
Pumpkins per 100 pounds gain ... pounds	4,520
Cost of feed per 100 pounds gain ... dollars	2.39

Feeding pumpkins and apples.—At the same time with the test outlined in the preceding paragraph, Burkett fed a lot of 3 pigs on a ration of apples and pumpkins, half and half, cooked. The pumpkins in all the New Hampshire experiments were raised at a cost of 40 cents per ton; the apples were common cider apples, or windfalls, and were valued at 10 cents per bushel.[b] The results are as follows:

Pigs ... number	3
Average weight at beginning, pounds	140
Total gain ... pounds	116
Days fed ... number	25
Average daily gain ... pounds	1.54
Milk consumed ... do	630

Pumpkins and apples ... pounds	3,762
Milk per 100 pounds gain ... do	545
Pumpkins and apples 100 pounds gain ... pounds	3,246
Cost of feed 100 pounds gain, dollars	4.65

The higher cost of gain in this test is attributed to the apples, and it is questioned whether it pays to feed them at a cost equal to or exceeding 10 cents per bushel.

ROOTS AND TUBERS.

Feeding roots to live stock is comparatively recent in the United States. Corn, with hay and ensilage, has been the principal maintenance during the winter months when pasture was not available. In hog feeding it is safe to say that, until very recent years, almost the only substitutes for pasture were pumpkins, artichokes, and clover or alfalfa hay in certain sections. In England and Canada, however, much dependence is placed on roots, and, while we may never reach the point in this country generally of fattening animals almost entirely on a root diet, the peculiar advantages to be gained by them, their great palatability, and the good effect on the health and thrift of the animal commend roots to the stockman.

A number of experiments have been reported recently on feeding roots to hogs.

At the Indiana Station, Plumb and Van Norman[c] conducted two experiments to compare a ration composed solely of grain with one where roots were added. In both experiments the grain ration was 1 part corn meal, 2 parts shorts, fed as slop. No drink other than water was given. In the first experiment mangels were fed; in the second the roots were sugar beets sliced and fed in the slop, and they were relished more than the mangels.

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[a] Bul. No. 66, New Hampshire Expt. Sta.

[b] New Hampshire has no legal weight per bushel for apples, and this bulletin did not state the weight used. The legal weight in other States varies from 44 to 50 pounds.

[c] Buls. Nos. 79 and 82.

At the Ontario Agricultural College, Day[a] fed four lots of pigs in pens as follows:

Lots I and II were made up of 4 grade Yorkshire pigs each from the same litter, about seven weeks old; Lots III and IV contained 5 grade Yorkshire pigs each from the same litter, about 9 weeks old. Lot I received barley and middlings; Lot II received barley and middlings with an equal weight of raw pulped mangels; Lot III received corn and middlings; Lot IV received corn and middlings with an equal weight of raw pulped mangels. The proportion of grain to middlings was 1:2 in all lots at the beginning of the experiment, and was gradually changed as the pigs increased in weight and age until it was 2:1 toward the close.

At the Utah Station, Foster and Merrill[b] conducted two experiments to compare a ration of bran and sugar beets with rations of corn meal, ground wheat, and corn meal and peas. In the first experiment Lot I received corn meal, Lot II received ground wheat, and Lot III received sugar beets with a one-third ration of bran. In the second experiment Lot I received a mixture of equal parts of corn meal and ground peas, Lots II and III being fed as in the first test. The pigs were fed in covered pens, and were given all they would eat. There were 3 in each lot.

At the Montana Station, Shaw[c] fed one lot of hogs on grain only and another on the same grain ration with sugar beets added. The following table shows the results of these experiments:

Value of roots as feed for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		
						Grain.	Roots.	Grain-fed lots.	Grain-and-root fed lots.	
									Grain.	Roots.
Indiana:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Grain	6	46	443	77	0.96	1,643	....	371	....	....
Grain and roots	6	44	356	77	.77	1,320	514	....	371	145
Grain	4	60	444	98	1.13	1,697	....	382	....	....
Grain and roots	4	60	382	98	.77	1,186	1,568	....	310	410
Ontario Agricultural College:[d]										
Grain	4	42	501	196	.64	....	....	439	....	....
Grain and roots	4	42	672	196	.86	....	....	....	380	....
Grain	5	55	664	196	.68	....	....	455	....	....
Grain and roots	5	55	744	196	.76	....	....	....	404	....

[a] An. Rpt., 1901.

[b] Bul. No. 70.

[c] Bul. No. 27.

[d] The grain per 100 pounds gain in the Ontario results is dry matter.

Value of roots as feed for pigs—Continued.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		
						Grain.	Roots.	Grain-fed lots.	Grain-and-root fed lots.	
									Grain.	Roots.
Utah:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	3	97	229	91	.85	1,279	....	558	....	....
Ground wheat	3	97	324	91	1.2	1,505	....	464	....	....
Bran and roots	3	97	167	91	.62	471	2,761	....	282	1,653
Corn meal and pease	3	87	410	122	1.12	1,672	....	407	....	....
Ground wheat	3	86	330	122	.90	1,390	....	403	....	....
Bran and roots	3	89	258	122	.70	880	[a] 1,771	....	341	686
Montana:										
Grain	7	111	557	66	1.20	2,967	....	532	....	....
Grain and roots	7	115	576	66	1.26	2,497	819	....	426	142
Average	....	....	....	....	....	....	....	442	359	427

[a] Includes 111 pounds of potatoes.

In the experiments tabulated here roots were fed in seven tests to 32 pigs, and in comparison grain was fed in nine tests to 38 pigs, making a total of sixteen lots and 70 pigs. In six of the seven tests where roots were fed there was a saving of grain. In one instance (in Indiana) nothing was gained by feeding roots. The average of feed per 100 pounds gain shows that feeding 427 pounds of roots saved 83 pounds of grain, or 19 per cent, which is a very high value for roots. This feature of root feeding has previously been remarked upon in this bulletin. Attention is called to it in nearly every instance where experimenters have fed roots successfully. Plumb and Van Norman[a] do not regard their results as showing great value for roots, but think that they have an effect on the appetite, digestion, and general health that is beneficial, particularly in winter. In the Ontario[b] experiments the equivalent for 100 pounds of meal was 319 pounds of roots in the first and 564 pounds in the second. Day calls attention to the fact that both figures are very high values for roots, and points out that, "according to analyses and digestion experiments, there is approximately about nine times as much digestible matter in a mixture of corn and middlings as there is in mangels. It is difficult to explain, therefore, how 564 pounds of mangels should prove equal to 100 pounds of meal." The pigs receiving mangels showed the effects of their feed in more growth and thrift than the others. They had less tendency to become fat, and the root ration was reduced for this reason. Day[b] explains this effect of root feeding to be due to a "beneficial effect on the digestive organs of the animals, causing them to digest their food better than did the others; for there is little doubt that hogs closely confined in pens are likely to suffer from indigestion." Shaw[c] explains the marked effect of roots in similar words, stating that the value for sugar beets for pigs is "derived not so much from the nutrients in the dry matter which they contain as from the influence they exert on digestion and assimilation." This action of roots in the ration is undoubtedly similar to what has already been noted in the case of dairy by-products and pasture. The improvement that roots bring about in the condition of the digestive system must also affect indirectly the entire system and thus promote the general health.

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[a] Bul. No. 79, Indiana Expt. Sta.

[b] An. Rpt., 1901, Ontario Agricultural College.

[c] Bul. No. 27, Montana Expt. Sta.

Henry found the results at three American stations to be that about 615 pounds of roots saved 100 pounds of grain. The Danish experiments give 600 to 800 pounds of mangels and from 400 to 800 pounds of fodder beets as the feeding equivalent of 100 pounds of grain.[a]

The average of the results here given indicates that about 515 pounds of roots saved 100 pounds of meal, a somewhat higher value for roots than that given in previously published work.

An experiment conducted by Shaw[b] at the Montana Station, the results of which were published since the foregoing figures were compiled, showed an average daily gain for pigs of 1.58 pounds, at a cost of $4.60 per 100 pounds gain on grain only (9.11 pounds of grain per head daily); a second lot, on grain and sugar beets (6.65 pounds grain and 4.58 pounds sugar beets per head daily) made an average daily gain of 1.64 pounds, at a cost of $3.80 per 100 pounds. There were 4 pigs in each lot and they were fed 50 days. As a sidelight on the possibilities of pork production in the irrigated Northwest, it is interesting to note that Shaw found his net profit from feeding these 8 pigs to be $14.12, "or 33 per cent on the investment in fifty days."

Comparing various roots.—At the Central Experimental Farm in Canada, Grisdale[c] fed four lots of pigs to compare the feeding value of turnips, mangels, and sugar beets. In each case the meal mixture fed consisted of one-half corn, the other half being equal parts of oats, pease, and barley. In addition each pig was given 3 pounds of milk daily and all the roots he would consume. The roots were fed as follows: Lot I, turnips fed pulped; Lot II, mangels fed pulped; Lot III, sugar beets grown for forage, fed pulped; Lot IV, sugar beets grown for sugar production, fed pulped. The results were as follows:

Value of various roots for pigs.

Ration.	Number of pigs.	Average weight January 7.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.		
						Meal.	Roots.	Milk.	Meal.	Roots.	Milk.
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Lot I, turnips	4	101.25	363	106	0.85	780	3,808	1,284	215	1,049	354
Lot II, mangels	4	96.75	389	106	.90	786	5,930	1,284	202	1,524	330
Lot III, forage beets	4	76.75	500	106	1.18	793	4,298	1,284	159	860	257
Lot IV, sugar beets	4	57.00	[d]528	138	.95	1,032	4,266	1,680	195	808	318

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[a] Feeds and Feeding, pp. 570, 571.

[b] Bul. No. 37.

[c] An. Rpt., 1901.

[d] Feeding ceased May 25.

On Lots I and II no deleterious results are mentioned in either buyers' or packers' reports. On Lot III the buyer reported 3 "select" and 1 "fat," and the packers' report was not so favorable to this lot as to Lots I and II. On Lot IV the buyer reported all "select;" there was no packer's report on carcasses of this lot.

In this experiment the pigs on forage beets made the greatest average daily gains and required the least feed for 100 pounds gain, the other lots standing in the order of sugar beets, mangels, and turnips. The results are remarkably low in feed requirements and would seem to show that roots and milk may be more advantageously combined than pasture and milk.

Day at Guelph and Shutt at Ottawa have found that the effect of roots on the carcass is not detrimental, but produces a firm bacon of good quality—a very essential matter to Canadian pig feeders. In this experiment neither buyers nor packers criticised adversely the pigs fed on turnips and mangels, and the carcasses of the sugar-beet pigs were all "select" (there was no packer's report on this lot); but the buyer found one carcass too fat in the lot fed on forage beets, and the packer's report was not so favorable as on the others.

Sugar beets alone.—At the Colorado Station, Buffum and Griffith[a] fed 4 pigs on sugar beets alone. There was some difficulty at first in inducing the pigs to eat beets, but after they had become accustomed to such a diet they took to it readily. At no time were the pigs able to eat beets enough to approach the conventional feeding standards; 12.50 pounds daily was the greatest amount they would take. For a brief period at the close (two weeks) forage beets were fed, the supply of sugar beets giving out. The results were as follows:

Average weight at beginning	pounds	100
Total gain	do	67
Days fed		99
Average daily gain	pound	.17
Average amount of feed eaten	do	1,027
Feed per 100 pounds gain	do	6,130
Cost per 100 pounds gain	dollars	12.30
Average profit with pork at 7 cents per pound	cent	.13
Dressed weight	per cent	77

Sugar beets alone are thus seen to be only a very expensive maintenance ration.

A comparison of sugar-beet pulp and sugar beets.—In Colorado, Buffum and Griffith[a] fed one lot of pigs on a ration of sugar-beet pulp and equal parts of wheat and barley; another on the same ration, except that sugar beets were fed instead of pulp; the results with a third lot, on equal parts of wheat and barley, are compiled in the table below as a check.

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[a] Bul. No. 74.

The pulp cost, laid down at the college, $1 per ton. It was piled on well-drained ground and kept well without an undue amount of fermentation. The beets fed were grown on the college farm. Their cost was estimated at $4 per ton. During the last two weeks of the experiment the supply ran out and forage beets were substituted for sugar beets. The change is not thought to have influenced results.

There was some difficulty in inducing the pigs to eat the pulp, but the sugar beets were eaten from the start, although they were apparently not relished at first. The following table shows the results:

Sugar-beet pulp compared with sugar beets.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.			Feed per 100 pounds gain.			Cost per 100 pounds gain.	Average profit at 7 cents per pound.
						Grain.	Pulp.	Beets.	Grain.	Pulp.	Beets.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Grain	4	95	120	104	1.16	546.50	......	....	450	......	......	4.50	3.90
Beet pulp and grain	4	97	88	99	.89	343	706	....	390	800	......	4.30	3.35
Sugar beets and grain	4	101	98	104	.94	416	......	391	420	......	400	5.00	2.98

Potatoes.—Clinton[a] reports an unsuccessful attempt at Cornell to feed potatoes raw and cooked. Some grain and skim milk were given in addition, but, while over 400 pounds of potatoes were eaten, the pigs made no progress and were getting out of condition when the experiment was brought to a close. The low temperature while the pigs were being fed, ranging between 29° and 30° F., is suggested as a reason for the poor results.

At the Central Experimental Farm[b] very satisfactory results were obtained from cooked potatoes, but raw potatoes produced little gain. In one experiment the pigs were given all the raw potatoes they would eat, but made no gain and the tubers were discontinued. In a second test a similar experience led to a change to cooked potatoes. The opinion of investigators at this station is that raw potatoes are of little value for feeding pigs, but when cooked they are worth about one-fourth as much as mixed grain.

The following table shows the results of three tests where cooked potatoes were fed with success. The meal fed was a mixture of equal parts by weight of ground barley, ground rye, ground frozen wheat, and bran:

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[a] Bul. No. 199, Cornell University Expt. Sta.

[b] Bul. No. 33.

Cooked potatoes for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average net gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.			Feed per 100 pounds gain.		
							Meal.	Potatoes.	Milk.	Meal.	Potatoes.	Milk.
		Lbs.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Potatoes (cooked), meal (soaked), skim milk	3	56	171	115	140	0.82	177	831	315	152	718	272
Potatoes (cooked), meal, skim milk	3	55	195	140	140	1.00	289	712	105	205	506	74
Potatoes (cooked), meal, skim milk	3	50	192	142	140	1.01	140	1,034	420	98	729	296

Sweet potatoes.—The Alabama, South Carolina, Maryland, and Florida stations have experimented with sweet potatoes with somewhat varying results.

At the Alabama Station, Duggar[a] fed one lot of pigs on a ration of three-fourths sweet potatoes and one-fourth ground cowpeas and another on a ration of equal parts of corn meal and cowpeas. After four weeks they were put through an intermediate period of one week and the rations were reversed, the lot that had formerly been on corn meal and cowpeas receiving the sweet potato ration. This was continued for four weeks longer, so that in all there were eight weeks' feeding on a sweet potato ration.

The ration of sweet potatoes and cowpeas proved very inferior to the ration of corn meal and cowpeas; the increase in live weight was nearly twice as great in the case of corn meal and cowpeas, and the dry matter per 100 pounds of gain was estimated at 600 pounds where sweet potatoes were fed to 360 pounds where corn meal was fed. Duggar refers to the difficulty of inducing the pigs to eat enough dry matter when sweet potatoes made up so much of the ration, and suggests a ration of equal parts of cowpeas and sweet potatoes as being more palatable and nutritious. He questions whether sweet potatoes can be profitably grown, stored, and fed to hogs unless the feeding value per bushel would be more than 10 or 15 cents. Where the pigs do the harvesting, especially on sandy soils, where the yield of sweet potatoes is ten or fifteen times that of corn, they may be an economical feed.

The results at the South Carolina Station were much more favorable to sweet potatoes. Newman and Pickett[b] fed a lot of 3 pigs, averaging 162 pounds in weight, on sweet potatoes only for forty-three days, beginning November 23. At the same time corn was fed to 3 pigs, averaging 156 pounds in weight. Two pigs in each lot were high-grade Berkshires and the third was a grade Duroc Jersey.

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[a] Bul. No. 93.

[b] Bul. No. 52.

The pigs on sweet potatoes ate 26.2 pounds per head daily and made an average daily gain of 0.86 pound. They ate 3,247 pounds of sweet potatoes for 100 pounds of gain.

The pigs on corn ate an average of 9.2 pounds of grain daily, and made an average daily gain of 1.39 pounds, requiring 602 pounds of corn for 100 pounds of gain.

It was estimated that, at 200 bushels per acre, sweet potatoes would produce 369.5 pounds of pork per acre, worth $18.47 when pork is worth 5 cents per pound. The gain from corn was 139.5 pounds of pork, and the corn yield was 15 bushels per acre on land similar to that on which the sweet potatoes were grown. At 5 cents per pound for pork, the money return for the corn was $6.97 per acre.

The Maryland Station[a] reports an attempt to maintain pigs exclusively on sweet potatoes. A lot of rather mature pigs was put on a ration of small sweet potatoes and "strings" that were fed raw twice a day for thirty-one days. It required over 5 tons of these potatoes for 100 pounds of gain, and the return from them was only about $1.60 per ton.

The value of this feed when given with grain was tested with a younger lot of pigs for thirty days. With this lot, 593 pounds of sweet potatoes, 277 pounds of milk, and about 60 pounds of grain were required for 100 pounds of gain, and the value per ton of the potatoes was estimated at $2.40, showing sweet potatoes to be more valuable when fed with grain and milk.

The Florida Station[b] fed a lot of 4 native hogs on a ration of equal parts by weight of sweet potatoes and wheat middlings, the ration being 3.5 pounds of each per 100 pounds live weight of hog. They were confined in an open pen and fed twice daily. The hogs averaged 101.5 pounds at the beginning of the test and increased in weight 31.16 per cent, or 126.5 pounds, at a cost of 5.6 cents per pound of gain for feed eaten.

At the Alabama Station, Duggar[c] penned 2 shoats, averaging 116 pounds, on sweet potatoes for thirty-five days. They were given, in addition, 2 pounds of ground corn and 1 pound of ground cowpeas per head daily. In the time specified they gained 67 pounds, an average daily gain of 0.93 pound, thus requiring 313 pounds of grain in addition to the sweet potatoes for each 100 pounds gain. Duggar states that the sweet potatoes were not relished greatly and that there was much waste of them, due probably to the relatively large amount of grain fed.

Artichokes.—At the Oregon Station[d] French took 6 Berkshire pigs from wheat stubble on October 22 and placed them on a field of artichokes that had been planted in April on deep-plowed ground, prepared, as for potatoes, in rows 3 feet apart, with the seed 18 inches apart in the row. The growth was vigorous and the yield abundant, the tops growing to a height of 7 feet during the season, and a trial plot showing a yield of 740 bushels per acre. The pigs had free access to the field and did all the harvesting. An attempt to sustain them entirely on the tubers failing, some shorts were fed in addition.

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[a] Bul. No. 63. [b] Bul. No. 55. [c] Bul. No. 122. [d] Bul. No. 54.

At Ottawa, Grisdale[a] sowed a plot of one-sixteenth acre with about 70 pounds of tubers on May 19, planting in rows 24 inches apart, 4 inches deep, and 20 inches apart in the rows. Six pigs were turned in October 3. Although the tubers were immature at that time, the tops were from 10 to 13 feet high. The pigs were allowed a daily grain ration of 1.5 pounds of a mixture composed of one-half corn meal and one-half of a mixture of equal parts of ground oats, pease, and barley.

In both experiments the Jerusalem artichoke (*Helianthus tuberosus*) was used. The following table shows the results:

Artichokes as feed for pigs.

Station.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Grain fed.	Grain per 100 pounds gain.	Cost of grain per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*
Oregon	6	162.6	244	50	0.81	756	309	1.85
Ottawa	6	104.6	197	21	1.57	189	96	1.80
Average							202.5	1.825

The cost of the meal in the Oregon experiment was estimated at $12 per ton; that in the Canadian one at $18 per ton. Valuing the meat made at $6.25 per 100 pounds, Grisdale estimates that, after deducting the cost of the meal fed, a balance of $10.61 is left for the artichokes fed, and deducting from this the cost of seed, planting, rent of land, etc., the one-sixteenth acre used gave a net return of pork worth $8.76.

ROUGHAGE.

Hogs are generally regarded as animals whose peculiar function is the conversion of concentrated feed into meat. Although the capacity for bulky feed that we find in the stomachs of cattle and sheep is lacking in hogs, a reasonable amount of bulk in the form of roots or hay is palatable and profitable. In many parts of the country, where concentrates are costly feeds, stockmen are forced to use substitutes for at least a part of the grain ration, both for fattening and maintenance, and over the entire country the winter ration is a problem. To solve these problems many western farmers have resorted to the use of alfalfa hay, and outside alfalfa districts clover hay is used. Considerable study has been devoted to this subject by the experiment stations.

Alfalfa hay.—The Kansas Experiment Station[b] has reported a series of experiments with drouth-resistant crops. Three of these experiments had to do with alfalfa hay. In the first, the hogs used were of mixed breeding—Berkshire and Poland China—representing about the average of Kansas farm hogs. The alfalfa was of good quality.

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[a] An. Rpt. 1900, Central Experimental Farm.

[b] Bul. No. 95.

Two lots were fed—one receiving the hay whole in greater quantity than it would consume, the other having ground hay. In the second test the meal-fed lot received some cotton-seed meal—0.16 pound to each pound of Kafir corn, which did not affect the hogs seriously. This test was conducted during the most severe weather of the winter, the thermometer registering 32° F. below zero February 12, ten days after the experiment began.

In the third test the grain was wet with water at the time of feeding. The alfalfa hay had been cut late and was rather woody.

The Utah Station[a] fed one lot of hogs on a mixture of equal parts by weight of chopped wheat and bran, wet. Another lot had the same grain ration with chopped alfalfa hay added. "The alfalfa used was well cured and was prepared by running through an ensilage cutter, the blades of which are arranged for cutting into half-inch lengths." The pigs were thrifty grade Berkshires.

The Montana Station[b] fed three lots of hogs to compare the feeding values of a grain ration with sugar beets and alfalfa hay as roughage with a ration of grain only. The results of the lots that were fed on grain alone and on grain and alfalfa hay are presented herewith. The lot on grain alone received a ration consisting, during the early part of the experiment, of 2 parts of damaged wheat and 1 part oats, barley taking the place of the wheat during the latter part of the experiment. The hay-fed lot had the same ration with alfalfa hay added. The alfalfa hay was run through a cutting box, moistened, and mixed with meal. The hogs were by a Berkshire boar out of high-grade Poland China sows. They had previously had the run of a stubble field, with some clover pasture.

The following table shows the results of these experiments:

Value of roughage for pigs.

Ration.	No. of pigs.	Average weight at beginning.	Total gain.	No. of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.	
						Grain.	Hay.	Grain.	Hay.
Kansas:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Kafir corn meal, dry	10	126	524	63	0.83	3,925	......	749	......
Kafir corn meal, dry, and whole alfalfa hay	10	127	909	63	1.44	4,679	659	515	72.4
Kafir corn meal, dry, and ground alfalfa hay	10	127	833	63	1.32	4,479	656	538	78.7
Kafir corn meal, and cotton-seed meal, wet	6	161	126	22	.95	681	......	540	......
Kafir corn meal, wet, and whole alfalfa hay	6	164	117	22	.88	629	251	538	214

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[a] Bul. No. 70.

[b] Bul. No. 27.

Value of roughage for pigs—Continued.

Ration.	No. of pigs.	Average weight at beginning.	Total gain.	No. of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.	
						Grain.	Hay.	Grain.	Hay.
Kansas - Continued.		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Kafir corn, whole	10	138	456	50	.91	2,910	......	640	......
Kafir corn meal	10	139	441	50	.88	2,872	......	653	......
Kafir corn, whole, and alfalfa hay	10	142	685	50	1.37	3,434	898	501	131
Kafir corn meal and alfalfa hay	10	140	686	50	1.37	3,535	844	516	123
Utah:									
Chopped wheat and bran	4	58	689	135	1.28	3,196	......	464	......
Chopped wheat and bran and chopped alfalfa hay	4	58	647	135	1.19	2,942	270	455	41.7
Montana:									
Grain only	7	111	557	66	1.20	2,967	......	532	......
Grain and alfalfa hay	7	111	552	66	1.19	2,683	370	486	67
Average:									
For lots fed grain only								593	......
For lots fed hay								505	89

The feeding value of alfalfa hay, as indicated in the foregoing tables, does not in the least warrant a claim that it can be used economically as the sole ration. In all but two instances a considerable saving of feed was found to be effected by its use, but the statement that its feeding value is almost equal to that of corn is true only within certain limits. Where hogs are confined to an exclusive grain ration, and especially where this is made up of a single grain, the addition of a moderate amount of hay to the ration will be relished and less grain will be required. At the same time, better and cheaper gains are usually made by hogs so fed than by those on grain alone, but the value of the grain saved is out of all proportion to the value of the hay fed, and the hay in the ration can not be used economically in more than very moderate amounts. This is a similar fact to that which has been found by many investigators with such bulky feeds as green clover, rape, roots, and skim milk. That it is bad economy to attempt the maintenance of hogs on alfalfa hay alone is shown by the experiment noted below by McDowell in Nevada.

A consideration of the approximate proportions of hay to grain fed in these experiments is of interest. The greatest proportion of hay to grain was fed at the Kansas Station and the ratio was 1:2.5. With this ratio the least daily gain was made. The gains were the most expensive of any of the lots, and no advantage accrued from the use of hay. The least proportion of hay (1:11) was fed at Utah and gave the most economical gains. The greatest daily gain and the greatest amount of grain saved was in a Kansas lot fed whole alfalfa hay and dry Kafir corn meal in the proportion of 1:7. The following table shows the effect of these rations in greater detail. The best results seem to come from the use of hay in the proportion of from one-seventh to one-fourth of the ration when hay makes up all the roughage:

Ratio of hay to grain in feeding hogs.

Ratio of hay to grain.	Average daily gain.	Feed per 100 pounds gain.		Grain saved.
		Grain.	Hay.	
Kansas:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1:2.5	0.88	538	214	1.8
1:4	1.37	501	131	139
1:4	1.37	516	123	137
1:7	1.44	515	72.4	234
1:7	1.32	538	78.7	211
Montana:				
1:7	1.19	486	67	46
Utah:				
1:11	1.19	455	41.7	9

Feeding alfalfa hay alone.—There is very little experimental work work on this phase of the subject. The opinions of experimenters and of stockmen generally seem to be that whenever hay alone is resorted to it is no better than a maintenance ration. In the alfalfa-growing districts hogs are frequently run through the winter at the haystacks owing to the scarcity and expense of a grain ration. At the Nevada Station, McDowell[a] fed two lots of 2 pigs each on a ration of alfalfa hay. The two lots ate in twenty-one days 99.12 pounds and 99.14 pounds, respectively, and lost in weight 33.25 pounds and 51 pounds, respectively, an average daily loss of 0.79 pound and 1.21 pounds, respectively. "While feeding hay alone the pigs spent much time curled up in the bedding, but when about the stalls were restless, and even in eating it was done in a ravenous way unlike that of a hearty, well-fed pig." After the hay-feeding period both lots were given grain and roots and made satisfactory gains.

Sugar beets compared with alfalfa hay.—The Utah Station[b] conducted three experiments, which give valuable data on the relative feeding value of sugar beets and alfalfa as winter roughage. In the first experiment Lot I had all the alfalfa hay they would eat and 2 pounds of corn meal per head daily. Lot II received all the beets they would eat and 2 pounds of bran per head daily.

In the second experiment Lot I had all the alfalfa hay they would eat and 2 pounds of bran per head daily; Lot II had all the alfalfa hay they would eat and 3 pounds of bran per head daily; Lot III had all the sugar beets they would eat and 2 pounds of bran per head daily; Lot IV had all the sugar beets they would eat and 3 pounds of bran per head daily.

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[a] Bul. No. 40.

[b] Bul. No. 70.

In the third experiment Lot I had all the alfalfa hay they would eat and 2 pounds of a grain mixture of equal parts by weight of bran and chopped frozen wheat per head daily; Lot II was fed all the alfalfa hay they would eat and 3 pounds of the same grain mixture as Lot I per head daily; Lot III had all the sugar beets they would eat and the same grain ration as Lot I; Lot IV was fed all the sugar beets they would eat and the same grain ration as Lot II.

The Montana Station[a] fed one lot of 7 pigs on a grain ration consisting of 2 parts of damaged (frosted) wheat and 1 part oats, with raw sugar beets; another lot of 7 pigs had the same grain mixture, with chopped alfalfa hay. Barley replaced the wheat during the latter part of the experiment.

The following table combines the results of these experiments:

Alfalfa hay compared with sugar beets for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.		
						Grain.	Hay.	Beets.	Grain.	Hay.	Beets.
Utah:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Alfalfa and corn meal	3	102	195	75	0.86	751	372	......	385	191	......
Sugar beets and bran	3	96	174	75	.77	[b]719	......	1,109	414	......	637
Alfalfa and 2 pounds bran per head daily	3	98	77	54	.47	315	242	......	407	312	......
Alfalfa and 3 pounds bran per head daily	3	102	85	54	.52	472	145	......	553	170	......
Sugar beets and 2 pounds bran per head daily	3	103	121	54	.75	315	......	1,870	251	......	1,541
Sugar beets and 3 pounds bran per head daily	3	102	155	54	.95	473	......	1,270	305	......	821
Alfalfa and 2 pounds grain per head daily	5	58	211	71	.59	700	388	......	332	136	......
Alfalfa and 3 pounds grain per head daily	5	61	292	71	.82	1,050	219	......	359	75	......
Sugar beets and 2 pounds grain per head daily	5	61	282	71	.79	700	......	3,024	247	......	1,072
Sugar beets and 3 pounds grain per head daily	4	92	301	71	1.06	1,050	......	1,843	348	......	611
Montana:											
Alfalfa and grain	7	111	552	66	1.19	2,683	370	......	486	67	......
Sugar beets and grain	7	114	576	66	1.26	2,497	......	819	426	......	142
Average, alfalfa	....	....	......	....	......	....	......	......	423	123	......
Average, sugar beets	....	....	......	....	......	....	......	......	358	......	617

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[a] Bul. No. 27.

[b] Includes 235 pounds of corn meal.

This table shows an average for pigs fed on grain and alfalfa of 423 pounds of grain and 123 pounds of hay per 100 pounds of gain, and an average for pigs fed on grain and sugar beets of 358 pounds of grain and 617 pounds of beets—a difference of 65 pounds of grain, or over 15 per cent in favor of sugar beets.

Alfalfa hay and sugar beets in a grain ration.—Since the foregoing results were compiled the Colorado Station[a] has reported results unfavorable to either hay or sugar-beet feeding. Nine Berkshire pigs, averaging about 150 pounds, were fed. Lot I received a mixture of approximately 2 parts barley and 1 part corn, and about one-half pound alfalfa hay daily; Lot II had the grain ration only; Lot III had the grain ration and about 1 pound of sugar beets daily. There was some difficulty at first to get the pigs in Lot I to eat alfalfa, but when it was cut fine and mixed with barley slop they would take it. The results were as follows:

Alfalfa hay compared with sugar beets for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.				Feed per 100 pounds gain.			Cost per 100 pounds gain.	Average profit, pork at 5 cents per pound.
						Corn.	Barley.	Hay.	Beets.	Grain.	Hay.	Beets.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Grain and alfalfa hay	3	162	110	97	1.13	410	191	55	......	544	49	.....	4.90	1.73
Grain only	3	155	105	97	1.08	381	174	.....	......	528	.....	.....	4.60	1.94
Grain and sugar beets	3	148	96	97	.99	350	184	.....	99	555	.....	103	5.20	1.26

In this experiment neither the feeding of beets nor hay gave economical results. Grain feeding was cheaper than either, although the gains from grain and hay were somewhat larger than those from the pigs on grain only. The proportion of hay to grain fed in this experiment was approximately 1:11; that of beets to grain was a little wider than 1:5.

Corn fodder.—The Maryland Station has conducted a number of experiments with ground corn fodder, or "new corn product," as it is otherwise called. This product is the ground residue of cornstalks from which the pith has been removed. It was fed to pigs varying in age at the beginning from eight to twelve weeks. All rations contained milk, and the fodder was fed in different proportions to note any possibly advantageous results from such a practice. No special advantages could be observed from feeding the corn fodder, either in lessening the amount of grain required for 100 pounds of gain or in lowering the cost, except after the pigs were six months old. For fairly mature pigs the "new corn product" probably would have an effect in a ration somewhat similar to that of alfalfa hay.

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[a] Bul. No. 74.

BREED TESTS.

INFLUENCE OF BREED ON FEEDING POWERS.

In the foregoing pages attention has been called to the fact that there is very little difference in the standards of excellence for the various breeds of what has come to be designated the "lard," "fat," "block," or "corn-belt" hog. Tests of the different breeds made in different parts of the country show that, with standards that are similar to a large extent, there is very little difference in the cost of pork production by the best representatives of any of the established breeds. Indeed, these experiments show rather more, for they indicate that the breeds of the bacon type rank well in economy of gain with those of the "corn-belt" lard type. Curtiss and Craig[a] quote Hayward of the Pennsylvania Station to the effect that the results obtained in Maine, Massachusetts, and Ontario show the feed eaten per 100 pounds gain by various breeds to be as follows: Poland China, 407 pounds; Berkshire, 419 pounds; Tamworth, 420 pounds; Chester White, 500 pounds; Duroc Jersey, 522 pounds. The writer has averaged results for six leading breeds obtained by various experiment stations when there were a sufficient number of tests and a total number of pigs large enough to make the averages thoroughly representative. The stations whose figures were used are Maine, Vermont, New York State, Michigan, Wisconsin, and Iowa, in the United States, and the Ontario Agricultural College and the Central Experimental Farm, in Canada. The following table shows a variation in feed per 100 pounds of gain from 344 to 418 pounds:

Feed required for 100 pounds gain by different breeds.

Breed.	Number of tests.	Number of pigs.	Feed per 100 pounds gain.
			Pounds.
Tamworth	16	92	344
Chester White	13	71	347
Poland China	22	96	357
Berkshire	23	121	369
Large Yorkshire	11	67	407
Duroc Jersey	11	66	418

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[a] Bul. No. 48, p. 444, Iowa Expt. Sta.

Iowa experiments.—Curtiss and Craig have reported the results of three years' feeding of purebred pigs of six leading breeds, including representatives of the Tamworth and Yorkshire breeds. While the pigs were with the dam, records were kept of all feed consumed and the loss or gain, and the loss or gain in weight of the sows was entered in the accounts of the total pork production before weaning. Henry reports the results of trials with 8 litters of pigs at the Wisconsin Station,[a] when he found the feed required for 100 pounds gain by both sows and pigs before weaning to be little more than that required by the pigs alone after weaning. In the Iowa tests there was a very marked variation in the maintenance of flesh by the sows, which was perhaps due rather more to individual than to breed differences, and which had much to do with the economy of the feeding before weaning. The average cost of 100 pounds of gain for the three years' experiments, both for the sows and pigs before the latter were weaned and for the pigs after weaning, was as follows:

Cost of 100 pounds of gain before and after weaning.[a]

Breed.	Sows and pigs before weaning.	Pigs after weaning.	Breed.	Sows and pigs before weaning.	Pigs after weaning.
Berkshire	$4.29	$2.33	Duroc Jersey	$5.61	$2.27
Poland China	3.15	2.23	Yorkshire	1.83	2.14
Chester White	3.27	2.46	Tamworth	2.22	2.42

[a] Bul. No. 48, Iowa Expt. Sta.

According to these figures, sows of the bacon breeds (Yorkshire and Tamworth) only made cheaper gains with their pigs before weaning than the pigs alone after weaning. The Poland China sows showed the cheapest gains among those of the lard, or fat, type.

After weaning the pigs, the Iowa Station[b] put on feed those that were in thrifty condition and compared the same breeds from this standpoint. The conditions of feed and management were as nearly alike as possible for each breed in each year's feeding. The nutritive ratio was 1:5.8 for all breeds in the first experiment, from 1:5.5 to 1:5.7 in the second, and from 1:7.1 in the third. The first year's work was nearly wrecked by hog cholera, so that the results of only a limited period of time were published. The following table has been arranged from the results, to show the feeding record of each breed in each experiment and the average of each breed for the three years' feeding.

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[a] Feeds and Feeding, p. 541.

[b] Bul. No. 48, Iowa Expt. Sta.

Breed tests of pigs—three years' experiments. [a]

Breed.	Number of pigs.	Average age at beginning.	Average weight at beginning.	Average weight at close.	Total gain.	Number of days fed.	Average daily gain.	Dry matter consumed.	Dry matter per 100 pounds gain.	Cost per 100 pounds gain.
Berkshire:		*Days.*	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
First experiment	10	59	26	90	631	92	0.68	2,920	462	3.01
Second experiment	10	43	31	192	1,588	153	1.03	6,056	381	2.17
Third experiment	10	65	43	214	1,717	164	1.04	....	481	2.23
Average	....	....	....	....	....	.....	.98	....	441	2.33
Poland China:										
First experiment	5	63	40	107	334	92	.72	1,418	424	2.76
Second experiment	8	59	38	201	1,234	153	1.00	4,844	392	2.24
Third experiment	10	54	32	193	1,606	164	.97	....	441	2.12
Average	....	....	....	....	....	.....	.90	....	419	2.23
Chester White:										
First experiment	10	59	33	103	689	92	.74	3,196	463	2.95
Second experiment	10	49	30	185	1,551	153	1.01	6,113	394	2.28
Third experiment	9	55	26	179	1,383	164	.93	....	506	2.41
Average	....	....	....	....	....	.....	.89	....	454	2.46
Duroc Jersey:										
First experiment	10	58	34	115	828	92	.90	3,206	383	2.45
Second experiment	9	60	39	207	1,517	153	1.10	5,124	337	2.07
Third experiment	10	52	29	187	1,575	164	.95	....	506	2.36
Average	....	....	....	....	....	.....	.98	....	410	2.27
Yorkshire:										
First experiment	6	69	35	109	447	92	.80	1,782	398	2.55
Second experiment	9	68	46	225	1,609	153	1.16	5,851	365	2.09
Third experiment	5	61	45	236	957	164	1.16	....	505	2.04
Average	....	....	....	....	....	.....	1.04	....	423	2.14
Tamworth:										
First experiment	7	49	33	104	502	92	.77	2,028	403	2.62
Second experiment	10	60	52	210	1,539	153	1.00	6,266	407	2.31
Third experiment	8	75	52	221	1,354	164	1.03	....	558	2.47
Average	....	....	....	....	....	.....	.93	....	456	2.42

[a] Bul. No. 48, Iowa Expt. Sta.

These figures show that the Yorkshires averaged highest in average daily gains, with the Berkshires and Duroc Jerseys tied for second place, and the Tamworth pigs next. In feed (digestible dry matter) required for 100 pounds gain, the Duroc Jerseys were first in least requirement, with the Poland Chinas next, the Yorkshires third, and the Tamworths last. In cost of 100 pounds gain the Yorkshires were first, the Poland Chinas second, the Duroc Jerseys third, and the Tamworths fifth. This evidence seems to disprove the charges sometimes made against the bacon breeds, namely, that these pigs make smaller and more expensive gains than those of other breeds.

Ontario experiments.—From the Ontario Agricultural College, Day has reported a number of experiments with six leading breeds. The pigs were fed for comparative purposes. At the close of each feeding period carcasses were examined for their suitability for the export trade, and reports were made thereon by the packers who killed the pigs. The following table shows the results of the feeding tests for five years, with the average of four:

Breed tests of pigs—five years' experiments.[a]

Breed.	Year of test.	Average weight at beginning.	Average weight at close.	Number of days fed.	Average daily gain.	Feed eaten.	Meal per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Berkshire	1896	66	185	117	1.010	475	398.00
	1897	53	145	90	1.030	301	327.17
	1898	50	170	112	1.070		380.79
	1899						[b]318.28
	1900				.803		409.00
Average of 4 tests					.978		378.74
Poland China	1896	69	190	117	1.080	507	417.00
	1897	52	128	90	.840	253	332.89
	1898	69	187	112	1.050		383.22
	1899						[b]349.99
	1900				.701		474.00
Average of 4 tests					.905		401.78
Duroc Jersey	1896	62	199	117	1.160	580	424.00
	1897	65	149	90	.940	302	358.05
	1898	59	179	112	1.070		376.04
	1899						[b]337.10
	1900				.883		426.00
Average of 4 tests					1.014		398.02
Chester White	1896	62	185	117	1.060	557	452.00
	1897	52	127	90	.830	255	340.00
	1898	56	175	112	1.060		377.77
	1899						[b]336.68
	1900				.666		433.00
Average of 4 tests					.902		400.69
Yorkshire	1896	50	177	117	1.080	589	468.00
	1897	60	144	90	.930	285	340.62
	1898	52	176	112	1.100		350.10
	1899						[b]334.85
	1900				.930		422.00
Average of 4 tests					1.010		395.18
Tamworth	1896	54	171	117	1.000	469	400.00
	1897	52	139	90	.970	289	330.92
	1898	48	167	112	1.060		377.77
	1899						[b]331.16
	1900				.642		462.00
Average of 4 tests					.918		390.17

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[a] An. Rpts., 1896-1900, Ontario Agricultural College. [b] Dry matter, not included in averages.

These figures show that the Duroc Jersey averaged first in average daily gains with 1.014 pounds, the other breeds following in this order: Yorkshire, Berkshire, Tamworth, Poland China, and Chester White. There is, however, very little difference between the Duroc Jersey, Yorkshire, and Berkshire in respect of average daily gains, and the Tamworth, Poland China, and Chester White form a second group, with average daily gains of slightly more than 0.90 pound. In the economy of gain the Berkshire stands first with 378.74 pounds as the amount of meal required for 100 pounds of gain, the other breeds following in this order: Tamworth, Yorkshire, Duroc Jersey, Chester White, and Poland China. In this respect the Berkshire is quite a little in the lead. The Yorkshire and Duroc Jersey form a group around 395 pounds and the Chester White and Poland China another group at 400 pounds. The Tamworth required 390.17 pounds meal for 100 pounds gain—somewhat less than the Yorkshire and Duroc Jersey.

Minnesota experiments.—At the Minnesota Station, Shaw[a] fed pigs of the Tamworth and Yorkshire breeds in comparison with Poland China. Like the Iowa trials, this was really a comparison of the feeding ability of pigs of the bacon type with those of the lard type.

They were fed in pens 8 by 12 feet, with access to yards, but without pasture. The grain fed consisted of shorts, corn meal, and ground barley in varying proportions, and in the first experiment skim milk was fed. In both experiments green and succulent feed, such as pease, oats, corn, rape, and roots, was fed. During the first experiment one lot of Poland China pigs was on a ration that was mainly of corn meal, some shorts being fed in addition. The pigs in the first experiment were sold at $4 per 100 pounds and those of the second at $4.85 per 100 pounds. The following are the results for the purebred lots:

Breed tests of pigs—two experiments.

Breed.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Feed eaten.			Cost per 100 pounds gain.	Profit.
						Meal.	Milk.	Green feed.		
First experiment:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dollars.*	*Dollars.*
Poland China	3	44	88	126	0.70	378	84	74	2.52	0.86
Poland China (corn-fed)	3	46	84	126	.67	398	44	143	2.31	.96
Tamworth	3	44	117	126	.93	418	44	144	2.01	1.89
Large Yorkshire	3	35	122	126	.97	419	53	161	2.02	2.07
Second experiment:										
Tamworth	3	51	119	126	.94	415	......	252	2.32	2.68
Large Yorkshire	3	41	134	126	1.06	427	......	252	2.11	3.40
Poland China	3	44	121	126	.96	454	......	224	2.48	2.58

Wisconsin experiments.—The Wisconsin Station[b] tabulated the results of feeding for the different breeds and crosses used in an experiment with pease and corn meal. The following table shows the averages:

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[a] Bul. No. 73.

[b] Eighteenth An. Rpt., p. 57.

Results of feeding pigs of various breeds and crosses.

Breeding.	Number of pigs.	Average amount of grain eaten daily.	Average daily gain.	Total gain per pig.	Feed per 100 pounds gain.	Cost per 100 pounds gain.	Internal fat.	Thickness of surface fat.
		Pounds.	*Pound.*	*Pounds.*	*Pounds.*	*Dollars.*	*Pounds.*	*Inches.*
Razorback-Poland China	2	4.27	0.985	166	433	4.967	13.35	2 705
Razorback-Berkshire	2	2.86	.57	119	505	5.772	9.52	2.32
Small Yorkshire	2	3.52	.875	148	400	4.556	9.67	2.21
Razorback	4	2.73	.52	110	547	6.227	10.878	1.99

Particular attention is called to the low gains of the Razorbacks, the large amount of feed they required for 100 pounds gain, and the large amount of internal fat.

In the Wisconsin[a] experiment to compare pease and middlings with corn meal the Berkshires made an average gain in one hundred and twenty-six days of 169 pounds—an average of 1.34 pounds daily for each pig. The Poland Chinas gained 153 pounds each—an average of 1.21 pounds each daily. The Yorkshires, leaving out of consideration a pig that fed poorly, made an average gain in one hundred and twenty-six days of 137 pounds—an average daily gain each of 1.08 pounds. The authors of the Wisconsin report state that this should not be regarded as a breed test.

These experiments, taken in connection with the evidence of investigators over the entire country, undoubtedly show that representative pigs of the different breeds do not differ materially either in the rate of gain or the economy with which the gains are made. Any marked differences in the breeds will be manifested in the suitability of the fattened animals for market and the quality of the carcass on the block. A very notable feature is the showing of the bacon breeds when compared with the lard breeds. The fact that a pig is a Yorkshire or a Tamworth can not be taken as prima facie evidence that it will make slow and expensive gains.

Value of different crosses.—At the Minnesota Station, Shaw[b] fed four lots of pigs to determine the relative value of Yorkshire pigs of first and second crosses. The pigs of the first cross were by a purebred Large Improved Yorkshire boar out of a high-grade Berkshire sow. Those of the second were sired by the same Yorkshire boar, out of a sow whose dam was the grade Berkshire that was the dam of the first litter and whose sire was a purebred Yorkshire. The four lots were therefore as nearly identical in breeding as possible without extreme inbreeding.

Lots I and III were first-cross pigs and Lots II and IV second cross. Lots I and II received a corn-and-oats diet and Lots III and IV a barley-and-oats ration; and each lot had an 8 by 12 foot pen in a piggery, with a small paddock adjoining, where they ran for an hour or two daily.

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[a] Seventeenth An. Rpt., p. 16.

[b] Bul. No. 60.

The corn-and-oats ration was 1 part corn to 3 parts oats during the first period; during the second, 2:2; during the third, 3:1; and during the fourth, corn only. In the barley-and-oats rations barley substituted corn in the same proportion. Grain was ground, soaked twelve hours, and a little salt given at each feed. The pigs received all they would eat with relish. Some green feed, such as corn, second-growth clover, rape, and cabbage, was given.

Feeding tests of different crosses.

Breeding.	Number of pigs.	Age at beginning.	Total weight at beginning.	Total weight at close.	Total gain.	Number of days fed.	Average daily gain.	Grain feed eaten.	Green feed eaten.	Grain feed per 100 pounds gain.	Green feed per 100 pounds gain.	Cost per 100 pounds gain.
		Days.	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Lot I, first cross	3	108	247	601	354	112	1.05	1,394	322	393	111	1.65
Lot II, second cross	3	108	275	603	328	112	.98	1,483	297	452	90	1.89
Lot III, first cross	3	108	247	526	279	112	.83	1,178	267	422	95	1.83
Lot IV, second cross	3	108	279	567	288	112	.86	1,284	297	445	103	1.96

Other comparative results were as follows:

Average daily gain of first-cross	pound	0.94
Average daily gain of second-cross	do	.92
Cost of 100 pounds gain of first cross	dollars	1.74
Cost of 100 pounds gain of second cross	do	1.93

Comparing differing crosses.—Shaw[a] conducted two experiments to compare crosses of different breeds. The pigs were fed in 8 by 12 foot pens, with access to yards and lots adjoining for exercise, but no pasture. They were fed eighteen weeks. The feed was a mixture of shorts, corn, and barley, some green and succulent feed in season, such as peas, oats, rape, corn, and roots was given in each experiment, and all conditions were similar, except that during the first experiment the pigs had skim milk.

The pigs of the first experiment were sold at $4 per 100 pounds; those of the second, at $4.85 per 100 pounds.

The breeding was as follows:

First experiment:
  Tamworth-Poland China cross.
  Second cross, Large Improved Yorkshire on Berkshire.
  Third cross, Large Improved Yorkshire on Berkshire.
  Large Improved Yorkshire-Poland China cross.

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[a] Bul. No. 73, Minnesota Expt. Sta.

Second experiment:
- Third cross, Large Improved Yorkshire on Berkshire.
- Large Improved Yorkshire-Poland China cross.
- Tamworth-Poland China cross.
- Large Improved Yorkshire-Poland China cross (Minnesota-bred dam).
- Large Improved Yorkshire-Berkshire cross.

In the first experiment "The Tamworth-Poland China and Large Improved Yorkshire-Poland China crosses were obtained similar to those above described[a] and from a pure Tamworth and pure Large Improved Yorkshire sire, respectively. The second cross, or grade, of Yorkshire on Berkshire was from a dam the progeny of a Large Improved Yorkshire sire and a dam essentially Berkshire, but not registered. The third cross of Yorkshire on Berkshire was of breeding similar in kind, but once removed further from the original Berkshire dam."

In the second experiment there were some slight changes; the pigs of one Yorkshire-Poland China lot were out of a dam reared in the corn belt, while those of the other were out of a Minnesota-bred dam. "In several instances, however, the blood lines were not only the same, but the animals in the experiment were from the same sire and dam, as were those of the previous year." The results follow:

Feeding tests of crossbred pigs.

Breeding.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Feed eaten.			Cost per 100 pounds gain.	Profit.
						Grain.	Milk.	Green feed.		
First experiment:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Tamworth-Poland China	2	47	118	126	0.94	456	83	80	2.24	1.61
Second cross, Yorkshire-Berkshire	3	56	131	126	1.04	499	72	108	2.17	1.84
Third cross, Yorkshire-Berkshire	3	33	104	126	.83	410	47	142	2.28	1.46
Yorkshire-Poland China	3	48	128	126	1.02	483	44	145	2.16	1.87
Second experiment:										
Third cross, Yorkshire-Berkshire	3	45	126	126	1.00	427	......	252	2.25	2.98
Yorkshire-Poland China	2	63	166	126	1.32	577	......	252	2.28	3.86
Tamworth-Poland China	3	48	147	126	1.17	482	......	252	2.16	3.64
Yorkshire-Poland China (Minnesota-bred dam)	3	49	158	126	1.25	527	......	252	2.18	3.89
Yorkshire-Berkshire	3	46	152	126	1.21	564	......	196	2.43	3.38

Among Shaw's conclusions are the following remarks:

That the experiments do not sustain the view that the results will be less satisfactory from each succeeding cross of Yorkshire on Berkshire.

That the cross of Large Improved Yorkshire and Tamworth breeds upon the

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[a] See experiments with crossbred swine, pp. 183, 184.

Poland China sows of the corn-reared types produces animals at once vigorous, shapely, of better growth, and relatively more profitable than pigs from the aforementioned sows.

INFLUENCE OF BREED ON THE CARCASS.

For the sake of convenience the term "slaughter test" is used in this bulletin to include everything from weighings on the floor of a packing house to a chemical analysis. Sufficient attention has not been paid to the effect of feed and conditions of management on the carcass, but the present drift of sentiment among workers in animal husbandry points to a more thorough study of the carcass in detail as a means of solving the problems that still confront the student and the feeder. No one can doubt that such investigations will have a high value when applied under feed-lot conditions.

At the close of the last two Iowa[a] experiments most of the hogs were shipped to Chicago and sold on the open market. In both experiments the different breeds had been fed on practically the same rations, and all conditions of feeding and management were similar; so that whatever differences might be found in the carcasses could very properly be ascribed to breed influence. In the packing house where the hogs were killed careful records were kept of the slaughtering, and elaborate reports made of these records. The following table has been arranged from these results. It shows the percentage of dressed weight of each breed and the total and average weights of the heads and viscera for each breed:

NOTES ON THE FOLLOWING TABLE.

NOTE.—The writer is under obligations to Swift & Co., Chicago, who killed the hogs, for the following explanation of terms used in these slaughter tests that are not self-explanatory:

Heads, gross.—The gross weight of the heads just as cut from the hogs, with tongues and lean meat in.

Heads, net.—The same heads trimmed for tank—tongues, cheek meat, and cheek-meat fat taken out.

Cheek meat.—Refers to the lean meat in the cheek of the hog. Scientifically expressed, includes masseter (*pterygoideus internus* and *externus*) muscles.

Cheek-meat fat.—The fat trimmed off in saving the lean meat.

Ham facings.—Refers to the facing of fat which is taken off the inside of the hams in order to give them a lean appearance and is taken off in all cases where American cut hams are made Where English long-cut hams are made this facing of fat is left on, accounting for the fact that in some of the tests ham facings are shown; in other tests they are not.

Plucks.—The liver, heart, and lungs comprise what is called the pluck. Total weight of the livers, hearts, and lungs added together should agree with the total weight of the plucks. Some differences in 1897 test, but weights balance approximately in 1898 test.

Bladders, gross.—The weight of the bladders as taken from the hogs filled, more or less, with urine.

Bladders, net.—Weight of the same bladders with the urine pressed out.

Gut fat.—Large intestines washed out.

Caul fat.—Omentum.

Ruffle fat.—Mesentery.

Bung guts, gross.—Floating colon and rectum combined is called the bung gut, and bung guts, gross, is weight before being cleaned.

Bung guts, net.—Same as above, but cleaned.

Paunches, gross.—Weight of stomachs as taken from the hogs.

Paunches, net.—Weight of stomachs cleaned.

Pig bags.—Refers to uteri.

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[a] Bul. No. 48.

Slaughter tests of purebred hogs.

Breed.	Number of pigs.	Dressed meat.	Melts (spleen).	Heads.		Tongues.	Cheek meat.	Cheek-meat fat.	Leaf lard.	Kidneys.	Gullets.	Gullet fat.
				Gross.	Net.							
		Per cent.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Berkshire	10	76.20	3.00	105.00	85.00	8.00	10.00	2.00	40.00	3.00	12.00	0.50
	9	77.90	1.75	96.00	78.00	8.00	8.75	1.12	57.00	5.75	5.50	1.25
Average		77.04	.25	10.58	8.58	.84	.99	.16	5.11	.46	.92	.09
Tamworth	10	78.40	5.00	115.00	95.00	7.00	8.00	2.00	70.00	5.00	9.50	.50
	4	78.60	1.50	43.75	36.00	3.50	3.50	.75	15.00	3.00	2.50	.50
Average		78.46	.46	11.34	9.36	.75	.82	.20	6.07	.57	.86	.07
Chester White	9	78.40	4.00	98.00	75.00	5.00	6.00	2.00	55.00	3.00	9.50	.50
	8	77.80	1.50	78.75	65.00	5.75	6.50	1.50	45.00	4.50	5.25	1.75
Average		78.10	.32	10.40	8.24	.63	.74	.21	5.88	.44	.87	.13
Poland China	8	78.20	3.00	75.00	60.00	5.00	6.00	2.00	48.00	5.00	7.00	1.00
	9	79.00	2.50	84.25	70.00	6.00	7.00	1.25	48.00	5.00	6.00	1.50
Average		78.62	.32	9.37	7.65	.65	.77	.19	5.65	.59	.76	.15
Duroc Jersey	9	77.10	4.00	100.00	82.00	8.00	8.00	2.00	62.00	3.50	9.00	1.00
	9	77.00	2.12	86.00	70.00	6.25	7.25	2.25	41.00	5.00	6.50	3.50
Average		77.05	.34	10.34	8.45	.79	.85	.23	5.73	.48	.86	.25
Yorkshire	9	79.00	4.00	110.00	93.00	8.00	8.00	1.00	50.00	4.83	10.00	1.00
	4	79.60	1.25	42.25	35.00	3.25	3.25	.75	23.00	2.50	2.50	.50
Average		79.18	.40	11.71	9.85	.87	.87	.13	5.62	.53	.96	.11

Slaughter tests of purebred hogs—Continued.

Breed.	Ham facings.	Plucks.	Livers.	Hearts.	Lungs.	Bladders.	Bladders.		Bladder fat.	Total weight of guts.	Gut fat.	Caul and ruffle.
							Gross.	Net.				
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Berkshire	4.00	64.00	32.00	6.00	15.00		3.00	1.00	0.50	205.00	24.00	26.00
		50.50	25.00	5.50	20.00	0.50				218.00	31.00	32.50
Average		6.03	3.00	.61	1.84					22.26	2.90	3.08
Tamworth	4.00	60.00	26.00	6.00	18.00		3.00	1.00	.50	200.00	30.00	25.00
		24.75	11.00	2.75	11.00	.50				91.00	13.00	14.50
Average		6.05	2.64	.63	2.70					20.80	3.07	2.82
Chester White	4.00	50.00	25.00	5.00	10.00		2.00	1.00	.50	173.50	30.00	25.00
		37.25	19.00	4.25	14.00	1.00				156.00	29.00	24.00
Average		5.13	2.59	.54	1.41					19.38	3.47	2.88
Poland China	4.00	50.00	27.00	5.00	10.00		2.50	.50	.50	128.50	27.00	23.00
	10.50	44.25	27.00	4.75	12.50	1.00				175.00	28.00	18.00
Average	.85	5.54	3.18	.57	1.32					17.85	3.24	2.41
Duroc Jersey	4.00	55.00	25.00	5.00	15.00		2.00	.50	.50	189.00	25.00	29.00
	8.00	43.50	25.50	5.00	13.00	.75				194.00	30.00	28.50
Average	.66	5.47	2.80	.56	1.56					21.28	3.05	3.20
Yorkshire	4.00	60.00	27.00	4.00	18.00		4.00	1.00	.50	194.00	33.00	22.00
		25.00	13.00	2.50	9.50	.50				82.00	16.00	12.50
Average		6.54	3.08	.50	2.12					21.23	3.77	2.65

Breed.	Bung guts.		Bung-gut fat.	Pig bags.	Small guts.		Stomachs.		Nutritive ratio.
	Gross.	Net.			Gross.	Net.	Gross.	Net.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Berkshire	7.00 14.00	5.00 6.00	10.00	3.00 2.25	40.00 34.00	25.00 19.00	15.00 21.00	12.00 14.00	1:5.6 1:7.1
Average	1.11	.58	....	.28	3.90	2.32	1.90	1.37	
Tamworth	8.00 7.50	6.00 3.00	10.00	2.00 2.50	44.00 12.00	31.00 8.00	16.00 11.00	14.00 7.00	1:5.6 1:7.1
Average	1.11	.64	....	.32	4.00	2.80	1.93	1.50	
Chester White	6.00 10.00	4.00 4.00	9.00	1.50 .75	31.00 25.00	20.00 15.00	15.00 15.00	10.00 11.00	1:5.5 1:7.1
Average	.98	.47	....	.13	3.30	2.06	1.76	1.24	
Poland China	5.00 15.00	4.00 5.00	5.00	3.00 1.75	27.00 27.00	18.00 17.50	10.00 15.50	7.00 13.00	1:5.7 1:7.1
Average	1.18	.53	....	.28	3.18	2.09	1.50	1.18	
Duroc Jersey	8.00 14.75	7.00 6.75	7.00	3.00 2.25	32.00 33.00	20.00 22.00	18.00 17.00	11.00 13.00	1:5.6 1:7.1
Average	1.27	.76	....	.29	3.61	2.33	1.95	1.33	
Yorkshire	5.00 7.00	4.75 3.00	10.00	2.50 .50	25.00 14.00	18.00 8.00	21.00 7.00	13.00 6.00	1:5.6 1:7.1
Average	.92	.60	....	.23	3.00	2.00	2.15	1.46	

The average of these tests shows the Yorkshire to be in the lead in dressed weight, the other breeds following in this order: Poland China, Tamworth, Chester White, Duroc Jersey, and Berkshire, the variation being from 79.18 per cent to 77.04 per cent.

Relative weights of vital organs.—The weight of vital organs is highly important. To ascertain what variations the Iowa[a] test showed in this respect the table below has been arranged. It shows the percentages of the weights of the vital organs to live weight for each breed in each experiment, with the average of both.

The average live weights of the hogs at the abattoir were as follows:

Average live weights of hogs of different breeds—Iowa experiments.

Breed.	1897.	1898.
	Lbs.	*Lbs.*
Berkshire	190	209
Tamworth	200	215
Chester White	177	181
Poland China	198	191
Duroc Jersey	202	180
Yorkshire	215	232

Relative weights of vital organs of purebred hogs.[a]

Breed.	Number of pigs.	Melts (spleen).	Tongues.	Kidneys.	Gullets.	Plucks.	Livers.	Hearts.
Berkshire:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Percent.*	*Percent.*
First experiment	10	0.16	0.42	0.16	0.63	3.37	1.68	0.32
Second experiment	9	.09	.43	.31	.29	2.68	1.33	.30
Average		.13	.42	.23	.46	3.03	1.50	.31
Tamworth:								
First experiment	10	.25	.35	.25	.48	3.00	1.30	.30
Second experiment	4	.18	.41	.35	.29	2.88	1.28	.32
Average		.23	.37	.28	.42	2.97	1.29	.31
Chester White:								
First experiment	9	.25	.32	.19	.60	3.14	1.57	.32
Second experiment	8	.10	.40	.31	.36	2.57	1.31	.29
Average		.18	.35	.25	.49	2.87	1.45	.30
Poland China:								
First experiment	8	.20	.33	.33	.46	3.24	1.75	.33
Second experiment	9	.15	.35	.29	.35	2.58	1.57	.28
Average		.17	.34	.31	.40	2.89	1.66	.30
Duroc Jersey:								
First experiment	9	.22	.44	.19	.50	3.02	1.38	.28
Second experiment	9	.13	.38	.31	.40	2.68	1.57	.31
Average		.18	.41	.25	.45	2.86	1.47	.29
Yorkshire:								
First experiment	9	.20	.41	.22	.52	3.10	1.40	.20
Second experiment	4	.13	.35	.27	.27	2.69	1.40	.27
Average		.18	.40	.24	.44	2.97	1.40	.23

[a] Bul. No. 48, Iowa Expt. Sta.

Relative weights of vital organs of purebred hogs—Continued.

Breed.	Lungs.	Bladders.	Bladders, net.	Total weight of guts.	Bung guts, net.	Small guts, net.	Stomachs, net.
Berkshire:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
First experiment	0.79	....	0.05	10.79	0.26	1.32	0.63
Second experiment	1.10	0.03	....	11.99	.33	1.04	.77
Average	.92	....	....	11.19	.29	1.16	.69
Tamworth:							
First experiment	.90	....	.05	10.00	.30	1.55	.70
Second experiment	1.28	.06	....	10.58	.35	.93	.81
Average	1.01	....	....	10.19	.31	1.37	.74
Chester White:							
First experiment	.62	....	.06	10.89	.25	1.25	.62
Second experiment	.97	.07	....	10.77	.28	1.04	.76
Average	.79	....	....	10.83	.26	1.15	.69
Poland China:							
First experiment	.65	....	.03	8.32	.26	1.17	.46
Second experiment	.73	.04	....	10.17	.29	1.02	.75
Average	.69	....	....	9.30	.28	1.09	.61
Duroc Jersey:							
First experiment	.83	....	.11	10.44	.39	1.10	.60
Second experiment	.80	.44	....	11.98	.42	1.36	.80
Average	.82	....	....	11.14	.40	1.22	.70
Yorkshire:							
First experiment	.93	....	.20	10.03	.25	.93	.67
Second experiment	1.08	.06	....	8.84	.32	.86	.64
Average	.96	....	....	9.65	.27	.91	.66

In the relative amounts of spleen there are only two variations from a general average—the Tamworths, with 0.23 per cent, and the Berkshires, with 0.13 per cent.

In weight of kidneys the Poland Chinas lead, with 0.31 per cent, the Berkshires being lowest, with 0.23 per cent.

There does not appear to be any particularly constant influence due to breed or type in the relative weights of those vital organs that constitute the pluck. The combined weights of liver, heart, and lungs should approximate that under the head of pluck; if, therefore, there is any influence of breed on the development and weights of these organs we should expect to find evidences of it in uniform and constant differences in weights. In the weight of plucks the Berkshires lead in the average, with 3.03 per cent, the Tamworth, Yorkshire, Poland China, Chester White, and Duroc Jersey following in the order named, the lowest weight being 2.86 per cent of the live weight. Yet, in relative weights of the organs that are included in the pluck, the Berkshires are but once in the lead—in the weight of the heart, where less variation is seen than in the weights of livers and lungs, the

Yorkshire being the only breed that shows much variation from the general average. The variation in weights of livers and lungs is quite erratic. Poland Chinas lead in relative weight of livers, with 1.66 per cent, the other breeds following thus: Berkshire, Chester White, Duroc Jersey, Yorkshire, and Tamworth, the least amount being 1.28 per cent of the live weight. The Tamworths lead in relative weight of lungs, with 1.01 per cent, the other breeds following in this order: Yorkshire, Berkshire, Duroc Jersey, Chester White, and Poland China, the lowest weight being 0.69 per cent of the live weight.

We find some appearance of uniformity in the weights of stomach and intestines. The heading "Total weight of guts" includes, among others, the three items that follow it. The Berkshires lead in this respect, with 11.19 per cent, the breeds following thus: Duroc Jersey, Chester White, Tamworth, Yorkshire, and Poland China, the lowest weight being 9.3 per cent of the live weight. The Duroc Jerseys lead in net weight of bung guts, with 0.4 per cent, the breeds following in this order: Tamworth, Berkshire, Poland China, Yorkshire, and Chester White, the lowest weight being 0.26 per cent of the live weight. The Tamworths lead in net weight of small guts, the weight being 1.37 per cent; the other breeds stand thus: Duroc Jersey, Berkshire, Chester White, Poland China, and Yorkshire, the lowest weight being 0.91 per cent. In net weight of stomachs the Tamworths lead, the breeds following in this order: Duroc Jersey, Berkshire, Chester White, Yorkshire, and Poland China, the weights ranging from 0.74 per cent to 0.61 per cent of the live weight. The record of the Berkshires and Duroc Jerseys is seen to be fairly uniform. Definite conclusions can not be drawn from these figures and it may be questioned whether, in the light of the facts concerning the feeding possibilities of the different breeds on similar rations, the improved breeds will show any marked and uniform differences in the relative weights of the internal organs when fed on the same feed.

Lard yield of different breeds.—By common consent, the name "lard hog" has been applied by many people to that type of animal the development of which has very largely been brought about on Amercan soil, in contradistinction from the "bacon" type of hog which has been brought to us from Great Britain and Canada.

The writer is under obligation to Swift & Co., Chicago, who killed the hogs used in the Iowa experiments, for the following information regarding the lard yield of the different breeds in the test of 1898. Concerning their figures, they say:

> We did not, on any of the tests made, tank the fats of each lot separately, the amounts being too small. However, we know approximately what these fats should yield in rendered lard, and we have attached herewith a statement showing the different test lots slaughtered by us during November, 1898, and what we estimate the fats, etc., should yield in lard.
>
> For your information we beg to say that the ham facings, heads, cheek-meat fat, gullet fat, gut fat, caul and ruffle fat, bones, tails, feet, and fat trimmings are,

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 47, PART III.

D. E. SALMON, D. V. M., Chief of Bureau.

THE HOG INDUSTRY.

SELECTION, FEEDING, AND MANAGEMENT.
RECENT AMERICAN EXPERIMENTAL WORK.
STATISTICS OF PRODUCTION AND TRADE.

BY

GEORGE M. ROMMEL, B. S. A.,
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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

as a rule, tanked for lard by most packers, although at times some of the bones, tails, and pig feet are saved for offal trade and not rendered. The raw leaf also at times is saved for neutral and not rendered out as steam lard.

We have, however, in the table attached shown what all these fats and bones, if rendered out as lard, would amount to, as all these fats and bones go to make up the yield published by the Cincinnati Price Current, quoted by you.

* * * These yields are lighter than the averages shown by the Cincinnati Price Current and can be explained for the reason that all the hogs in these tests were made into English cuts, which invariably show a less yield in lard, on account of the smaller percentage of fats being tanked, than the same hogs would show if cut up as American cuts.

In estimating the yield of lard from the different fats, etc., the percentages of lard to actual weight for the various items are given as follows:

		Lard equivalent.
Ham facings	per cent	75
Heads, cheek-meat fat, gullet fat	do	35
Leaf lard	do	95
Bones and tails	do	17
Fat trimmings	do	75

The lard from the gut fat and the caul and ruffle fat is estimated at 2 per cent of the live weight.

The following table shows the calculations for all the hogs of the 1898 test for which a slaughter record was kept:

Lard yield of different breeds.

Breed.	Number of hogs.	Live weight.	Average live weight.	Ham facings.		Heads, cheek-meat fat, and gullet fat.		Leaf lard.	
				Weight.	Lard equivalent.	Weight.	Lard equivalent.	Weight.	Lard equivalent.
		Pounds	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Duroc Jersey	9	1,620	180	8	6	78.75	27.56	41	38.95
Poland China	9	1,720	191	10.5	7.87	72.75	25.46	48	45.60
Tamworth	4	860	215	....	....	37.25	13.03	15	14.25
Berkshire	9	1,880	209	....	....	80.37	28.13	57	54.15
Yorkshire	4	930	232	....	....	36.25	12.68	23	21.85
Chester White	8	1,450	181	....	....	68.25	23.88	45	42.75

Breed.	Number of hogs.	Gut, caul, and ruffle fat—Lard equivalent.	Bones and tails.		Fat trimmings.		Yield of total lard.	Average yield of lard.	Proportion of live weight.
			Weight.	Lard equivalent.	Weight.	Lard equivalent.			
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
Duroc Jersey	9	32.40	56.50	9.60	91.5	68.62	183.13	20.35	11.30
Poland China	9	34.40	59	10.08	103	77.25	200.61	22.29	11.66
Tamworth	4	17.20	39.50	6.71	56.5	42.37	93.56	23.39	10.88
Berkshire	9	37.60	67.25	11.43	103	77.25	208.56	23.17	11.09
Yorkshire	4	18.16	35.75	6.08	64	48	107.21	26.80	11.57
Chester White	8	19	53.25	9.05	88.5	66.37	161.05	20.13	11.11

INFLUENCE OF FEED ON THE CARCASS.

INFLUENCE OF WIDE AND NARROW RATIONS.

One of the earliest subjects for investigation in pork production was the influence of feed on the carcass. Following this line of study experiment-station workers have proved pretty accurately that, where a pig is fed a ration that is poor in those feed constituents whose function is to build up muscular fiber and is rich in carbohydrates, the carcass will probably show a development of fat at the expense of the lean meat (muscular fiber), and that, where a large proportion of protein is fed and a relatively small amount of carbohydrates, there is a correspondingly smaller development of fat and a larger development of muscular tissue and bone. Out of this came the ideas that instructed farmers to "feed for lean," or, rather, to strike a mean between rations and feed one that would supply fat, energy, and muscle-producing materials in the requisite proportions. The slaughter test early accompanied this branch of investigation, and from a mere estimation of the relative amounts of fat and lean has come to include the weighings of the internal organs and to involve chemical analyses.

The slaughter test was a feature of the experiments in Wisconsin and Iowa with wide and narrow rations that are discussed in the foregoing pages. The following tables show the data for the slaughterings in the actual and relative weights and the measurements of the parts.

The Wisconsin experiments.—The following table shows the slaughter test of the Wisconsin pigs that were fed a ration of ground pease, middlings, and milk in comparison with corn meal and milk:

Slaughter test of pigs fed a ration of ground pease and shorts, in comparison with corn meal.[a]

Breed.	Gain in eighteen weeks.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Liver.	Kidney.	Intestines and stomach.	Length of body.	Length of small intestines.	Length of large intestines.	Intestinal fat.	Kidney fat.
Lot I. Corn meal and milk:	*Lbs.*	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Lbs.*	*Lbs.*
Berkshire.....	190	270	218.0	80.74	7.1	3.7	6.0	19.7	43.0	789.0	216.0	6.3	12.5
Do.........	197	282	230.0	81.56	7.0	2.9	4.0	15.8	42.0	689.0	180.0	5.2	13.25
Yorkshire.....	115	177	131.0	74.00	6.2	.....	6.0	14.0	39.0	758.0	....	3.0	7.0
Poland China.	156	229	180.0	78.61	5.3	.....	5.0	14.5	41.0	730.0	204.0	3.0	8.0
Berkshire.....	143	227	187.0	82.37	6.1	2.7	6.0	16.7	39.0	786.0	174.0	3.6	7.5
Do.........	182	256	207.0	80.85	6.1	.7	6.0	18.7	42.0	789.0	....	5.1	11.0
Poland China.	214	300	230.0	79.66	7.0	.....	6.0	22.0	43.0	784.0	....	4.3	12.0
Average	171	249	197.5	79.6	6.4	3.0	5.6	17.3	41.3	760.7	193.5	4.35	10.18

[a] Seventeenth An. Rpt., Wisconsin Expt. Sta.

Slaughter test of pigs fed a ration of ground pease and shorts, etc.—Continued.

Breed.	Gain in eighteen weeks.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Liver.	Kidney.	Intestines and stomach.	Length of body.	Lenth of small intestines.	Length of large intestines.	Intestinal fat.	Kidney fat.
Lot II. Ground pease, shorts, and milk:	*Lbs.*	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Lbs.*	*Lbs.*
Poland China	153	208	151	74.38	5.6	.....	6.0	19.5	38.0	702.0	....	3.0	7.0
Do	95	167	128	76.69	7.3	.....	5.0	14.3	34.0	708.0	....	2.8	2.5
Yorkshire	139	217	171	78.08	8.3	.....	7.0	22.5	40.0	799.0	240.0	3.3	7.0
Do	167	217	160	73.73	8.0	.....	5.0	24.0	43.0	720.0	....	3.0	7.25
Poland China	147	225	170	75.55	6.5	5.7	7.0	20.5	39.0	741.0	....	3.7	10.0
Berkshire	168	241	200	82.98	8.8	4.5	6.0	20.0	41.0	678.0	180.0	3.4	8.8
Do	244	215	178	82.69	5.7	4.0	5.0	18.4	39.0	708.0	180.0	5.0	10.5
Do	158	223	191	86.03	7.2	3.9	7.0	20.0	40.0	802.0	....	3.4	7.5
Average	146	213	169	78.88	7.17	4.5	6.0	19.9	39.2	732.2	200.0	3.4	7.56

In this table it is found that the vital organs of the pigs on ground pease and middlings averaged heavier in proportion to their live weight than those on corn meal. These facts are best illustrated in the following table:

Average actual and relative weights of blood, vital organs, and fat of pigs fed on wide and narrow rations.[a]

	Wide ration.		Narrow ration.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Live weight	249.00	100.00	213.0	100.00
Dressed weight	197.50	79.60	169.0	78.88
Blood	6.40	2.57	7.17	3.37
Liver	3.00	1.20	4.5	2.11
Kidneys	.35	.14	.375	.18
Intestines and stomach	17.30	6.95	19.9	9.34
Intestinal fat	4.35	1.75	3.4	1.60
Kidney fat	10.18	4.09	7.56	3.55

[a] Seventeenth An. Rpt., Wisconsin Expt. Sta.

We see that the pigs fed on pea meal, middlings, and skimmed milk developed very much more in the vital organs in proportion to their live body weight than those fed on corn meal and skimmed milk. The difference was most marked in the livers, where the relative weight for the narrow-ration pigs was almost twice as great as for the wide-ration pigs. The same proportion does not hold when the relative lengths of intestines to body lengths are compared. There is very little difference between the pigs of the two lots in this respect. The ratio of body length to that of the small intestine in the wide-ration pigs was 1:18.42; to that of the large intestine, 1:4.69. The ratio of body length to the length of small intestine of the narrow-ration pigs was 1:18.68; to that of the large intestine, 1:5.10.

The following table shows the slaughter test of the pigs fed pea meal and shorts in comparison with corn and rye meals:

Slaughter test of pigs fed a ration of pea meal and shorts in comparison with corn and rye meals.[a]

Breed.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Intestines.	Spleen.	Liver.	Stomach.	Heart.	Intestinal fat.	Kidney fat.	Length of small intestines.	Length of large intestines.	Length of body.	Weight of kidneys.
Lot I, corn and rye meals:	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Ozs.*
Poland China	223.0	183.0	82.0	5.20	18.10	2.4	3.20	4.80	8.00	3.40	7.87	660.0	187.2	38.5	8.00
Yorkshire	208.0	162.0	77.8	5.40	17.30	4.0	3.00	6.60	8.00	2.80	6.00	684.0	196.8	39.5	6.00
Berkshire	214.0	175.0	81.7	4.90	15.60	3.2	2.70	3.10	8.00	2.70	8.50	615.0	180.0	38.0	8.00
Razorback-Poland China	244.0	195.0	79.9	6.40	17.50	4.8	3.50	4.20	9.60	2.70	9.00	684.0	168.0	.....	10.00
Do	182.0	144.0	79.1	4.70	15.30	4.0	2.50	4.10	8.00	2.70	7.87	624.0	168.0	37.0	5.00
Average	212.2	171.8	80.1	5.32	16.76	3.8	2.98	4.36	8.32	2.68	7.84	653.4	180.0	33.2	7.40
Lot II, pea meal and shorts:															
Berkshire	205.0	158.0	77.0	4.70	15.30	4.8	4.00	4.10	6.40	2.50	5.50	615.0	184.8	37.0	6.25
Poland China	179.0	140.0	78.2	5.30	16.90	3.2	3.80	4.10	8.00	2.30	8.30	610.2	192.0	34.0	9.00
Razorback-Poland China	177.0	138.0	75.1	5.40	18.10	3.2	3.10	4.60	6.40	2.70	6.50	607.2	184.8	33.5	8.00
Do	203.0	152.0	74.8	6.20	24.00	4.8	3.80	5.70	8.80	3.80	9.37	732.0	204.0	38.0	16.00
Average	191.0	145.6	76.2	5.40	16.57	4.0	3.66	4.62	7.40	2.82	7.41	641.1	188.4	35.5	9.86

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

For the sake of uniformity the following table has been arranged from the Wisconsin figures to show the relative weights of blood, vital organs, and fat for the pigs of this experiment:

Average actual and relative amounts of blood, vital organs, and internal fat of pigs fed pea meal and shorts in comparison with corn and rye meals.[a]

	Wide ration.		Narrow ration.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Live weight	214.2	100	191	100
Dressed weight	171.8	80.1	145.6	76.2
Blood	5.32	2.48	5.4	2.83
Liver	2.98	1.39	3.66	1.92
Heart	.52	.24	.4625	.24
Stomach	4.36	2.04	4.62	2.42
Intestines	16.76	7.82	16.57	8.15
Kidneys	.4625	.22	.61625	.32
Spleen	.2375	.11	.25	.13
Intestinal fat	2.68	1.25	2.82	1.48
Kidney fat	7.84	3.66	7.41	3.88

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

In this experiment the differences in the relative weights of the vital organs is evident, but is by no means as marked as it was in the experiment which compared corn meal and the mixture of pea meal and middlings. In fact, while the differences are uniformly in favor of the pigs fed a narrow ration, they are hardly large enough to be of moment in such a test. There was no difference in the relative weights of the hearts of the two lots. The relative length of body to length of intestines is still more contradictory in this test, being 1:19.68 and 1:5.43, respectively, for the small and large intestines of the wide-ration pigs; and 1:18.06 and 1:5.30, respectively, for the small and large intestines of the pigs fed the ration of pea meal and shorts. If it is true that a narrow ration has an influence on the development in weight and length of the vital organs, the fact that the rations were somewhat wider in this experiment than in the first one may have caused this result, although it is difficult to see what effect the widening could have had with one lot more than with another, because the increase in the ration was the same for both lots. A more reasonable explanation would be that the greater disparity in the variety of feed in the first experiment was the cause for the more pronounced development in the weight of the vital organs and blood. This experiment was the one that showed the advantage in feeding value of the narrower ration, which fact merely serves to complicate matters. A peculiar fact in this experiment is the greater accumulation of interna fat by the pigs on the narrow ration.

The following table shows the slaughter test of the pigs fed pea meal in comparison with corn meal:

Slaughter test of pigs fed a ration of corn meal in comparison with one of ground pease.[a]

Breed.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Intestines.	Spleen.	Liver.	Heart.	Capacity of stomach.	Intestinal fat.	Kidney fat.	Length of small intestines.	Length of large intestines.	Length of body.	Weight of kidneys.
Lot I, ground peas:															
Razorback-	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Ozs.*
Berkshire....	171.0	130.0	76.0	4.40	13.70	4.00	2.20	8.00	9.20	3.10	7.125	688.0	180.0	37.5	8.0
Yorkshire	189.0	144.0	76.5	5.80	15.80	3.20	3.20	6.40	8.30	1.90	8.250	600.0	222.0	36.0	6.0
Razorback.....	186.0	142.0	76.3	5.20	13.70	3.20	2.90	6.40	7.90	3.70	7.187	636.0	180.0	39.5	10.0
Razorback-Poland China...	219.0	167.5	76.8	6.80	18.20	2.40	3.50	6.40	9.70	3.50	9.250	636.0	192.0	39.0	14.0
Razorback.....	191.0	151.0	79.0	6.10	13.00	4.80	2.40	6.40	10.10	4.70	9.593	666.0	174.0	39.5	10.0
Average	191.2	146.9	76.9	5.66	14.88	3.52	2.84	6.72	9.04	3.80	8.281	649.2	189.6	38.3	9.6
Lot II, corn meal:															
Razorback.....	147.0	120.0	80.0	4.00	9.80	4.00	2.10	6.40	7.80	3.00	7.187	536.0	144.0	38.5	6.0
Do	104.0	81.0	77.8	3.40	7.50	4.00	1.40	4.80	7.10	3.20	2.937	528.0	150.0	34.5	5.5
Yorkshire	188.0	147.0	76.5	4.90	13.40	1.60	2.30	4.80	9.90	1.20	8.000	640.0	198.0	37.0	7.0
Razorback-Poland China	237.0	193.0	80.0	5.60	15.50	3.20	2.80	8.00	9.10	4.70	9.250	660.0	192.0	42.5	14.0
Razorback-Berkshire....	148.0	117.0	79.0	3.70	10.40	3.20	2.20	6.40	9.70	2.70	6.125	522.0	174.0	34.5	5.5
Average ...	164.8	131.6	78.6	4.32	11.32	3.20	2.16	6.08	8.72	2.96	6.700	577.2	171.6	37.4	7.6

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

The following table has been arranged from these figures in a similar manner as the foregoing ones and for the same reasons:

Average actual and relative amounts of blood, vital organs, and internal fat of pigs fed pea meal in comparison with corn meal.[a]

	Wide ration.		Narrow ration.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Live weight	164.8	100.0	191.2	100.0
Dressed weight	131.6	78.6	146.9	76.9
Blood	4.32	2.58	5.66	2.97
Liver	2.16	1.29	2.84	1.49
Heart	.38	.23	.42	.22
Capacity of stomach[b]	8.72	5.22	9.04	4.74
Intestines	11.32	6.78	14.88	7.80
Kidneys	.475	.28	.60	.31
Spleen	.20	.12	.22	.12
Intestinal fat	2.96	1.77	3.8	1.99
Kidney fat	6.70	4.01	8.281	4.34

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

[b] The average capacity of the stomachs of the pigs in this experiment was determined "by emptying them of their natural contents and estimating the capacity of each by the number of pounds of water they would contain."—Eighteenth An. Rpt., p. 50, Wisconsin Expt. Sta.

These figures do not show quite the same uniformity in weights of vital organs as do the preceding ones. In the relative weight of hearts and capacity of stomachs, there is a slight difference in favor of the pigs on the wide ration, although the actual weights of these organs are greater in the case of the narrow-ration pigs. The ratios of body length to length of intestines, however, favored the narrow-ration lot, being 1:16.95 and 1:4.95, respectively, for the small intestine and large intestine of the pigs on pea meal, and 1:15.43 and 1:4.59, respectively, for the small intestine and large intestine of the pigs on corn meal. A large proportion of these pigs were razorbacks or razorback crosses. In this experiment there was also a greater accumulation of internal fat by the narrow-ration pigs than by those on the wide ration.

The Iowa experiments.—The pigs fed in a comparative test on wide and narrow rations at the Iowa Station were slaughtered at the close of the experiments and data compiled in the same manner as with those in the breed test. The following table shows the report of the packers on the slaughter test. It has been arranged so as to show the averages for both tests:

[End of Part II.]

Slaughter test of pigs fed on wide and narrow rations.[a]

Ration.	No. of pigs.	Dressed weight.	Melts (spleens).	Heads.		Tongues.	Cheek meat.	Cheek-meat fat.
				Gross.	Net.			
Wide ration:		*Per cent.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	5	79.30	3.00	60.00	48.00	5.00	5.00	2.00
Second experiment	4	77.00	1.00	39.75	33.00	2.75	3.25	.75
Average per pig	....	78.28	.44	11.08	9.00	.86	.92	.31
Narrow ration:								
First experiment	5	77.10	2.00	50.50	40.00	5.00	5.00	.50
Second experiment	4	74.10	1.00	34.75	28.50	2.50	3.00	.75
Average per pig	....	75.77	.33	9.47	7.61	.83	.89	.14

Ration.	Leaf lard.	Kidneys.	Gullets.	Gullet fat.	Ham facings.	Plucks.	Livers.	Hearts.
Wide ration:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	40.00	2.00	5.67	0.33	4.00	31.00	15.00	4.00
Second experiment	19.00	2.25	2.50	.75	3.50	18.00	11.00	2.00
Average per pig	6.56	.47	.91	.12	.83	5.44	2.89	.67
Narrow ration:								
First experiment	41.00	2.00	5.50	.50	4.00	32.00	16.00	4.00
Second experiment	17.00	1.75	2.00	.50	1.75	16.00	11.00	1.75
Average per pig	6.44	.42	.83	.11	.64	5.33	3.00	.64

Ration.	Lungs.	Bladders.	Bladders.		Bladder fat.	Total weight of guts.	Gut fat.	Caul and ruffle.
			Gross.	Net.				
Wide ration:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	6.00	....	1.50	0.50	0.50	100.00	30.00	18.00
Second experiment	5.00	0.50	....	....	....	86.00	14.00	11.50
Average per pig	1.22	....	....	....	....	20.67	4.89	3.28
Narrow ration:								
First experiment	7.00	....	1.50	.50	.50	124.00	22.00	16.00
Second experiment	3.50	.50	....	....	....	90.00	7.00	10.25
Average per pig	1.17	....	....	....	....	23.78	3.22	2.92

Ration.	Bung guts.		Bung-gut fat.	Pig bags.	Small guts.		Stomachs.	
	Gross.	Net.			Gross.	Net.	Gross.	Net.
Wide ration:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	4.00	3.75	5.00	2.00	23.00	14.00	13.00	7.00
Second experiment	5.00	3.00	....	1.25	14.00	8.00	8.00	5.50
Average per pig	1.00	.75	....	.36	4.11	2.44	2.33	1.39
Narrow ration:								
First experiment	4.00	3.00	5.00	.50	24.00	12.00	13.00	6.00
Second experiment	8.75	6.00	....	1.75	15.75	13.00	6.75	4.00
Average per pig	1.42	1.00	....	.25	4.42	2.78	2.19	1.11

[a] Bul. No. 48, Iowa Expt. Sta.

The figures of the above table have been arranged in the following manner to show the results of the slaughter test in percentages:

Relative weights of vital organs of pigs fattened on narrow and wide rations.

Ration.	No. of pigs.	Melts (spleens).	Tongues.	Kidneys.	Gullets.	Plucks.	Livers.	Hearts.
Wide ration:		*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*
First experiment	5	0.25	0.41	0.17	0.47	2.56	1.24	0.33
Second experiment	4	.14	.39	.30	.36	2.57	1.57	.29
Average		.21	.41	.22	.43	2.57	1.36	.32
Narrow ration:								
First experiment	5	.19	.47	.19	.51	2.99	1.50	.37
Second experiment	4	.14	.37	.26	.29	2.33	1.60	.26
Average		.17	.43	.22	.43	2.73	1.54	.33

Ration.	Lungs.	Bladders.	Bladders, net.	Total weight of guts.	Bung guts, net.	Small guts, net.	Stomachs, net.	Dressed weight.
Wide ration:	*Per ct.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*
First experiment	0.50		0.04	8.26	0.31	1.16	0.58	79.3
Second experiment	.71	0.07		12.29	.43	1.14	.78	77.0
Average	.58			9.75	.35	1.15	.66	
Narrow ration:								
First experiment	.65		.05	10.65	.28	1.12	.56	77.1
Second experiment	.50	.07		18.08	.37	1.89	.58	74.1
Average	.60			12.19	.51	1.43	.57	

This table shows the same tendency that has been remarked upon for pigs on a narrow ration to show greater relative weight of vital organs than those on a wide one. In relative weight of spleens and stomachs (net), those of wide-ration pigs are heavier; in the weight of kidneys and gullets the two lots are equal, and they are very nearly equal in relative weight of hearts. The great difference existing between the relative weights of the livers of the two lots gives a considerable advantage in relative weight of plucks to the narrow-ration pigs and the lead of the narrow-ration pigs in intestines gives them larger relative total weight of guts. The wide-ration pigs dressed out the greater weight of carcass.

The following table shows, from data furnished by Swift & Co., the actual and relative amounts of lard yielded by these pigs:

Lard yield of hogs fed narrow and wide rations.

Ration.	No. of pigs.	Live weight.		Ham facings.		Heads, cheek-meat fat, gullet fat.		Leaf lard.	
		Total.	Average.	Weight.	Lard equivalent.	Weight.	Lard equivalent.	Weight.	Lard equivalent.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Wide	4	700	175	3.75	2.62	34.50	12.07	19	18.05
Narrow	4	690	172	1.75	1.31	29.75	10.41	17	16.15

Lard yield of hogs fed narrow and wide rations—Continued.

Ration.	No. of pigs.	Gut fat, caul, and rufflefat.	Bones and tails.		Fat trimmings.		Yield of lard.		Proportion of live weight.
		Lard equivalent.	Weight.	Lard equivalent.	Weight.	Lard equivalent.	Total.	Average.	
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
Wide........	4	14.00	24.75	4.21	37.5	28.12	79.07	19.77	11.29
Narrow.....	4	13.80	21.75	3.69	37	27.75	73.11	18.28	10.59

This table shows results contrary to the last two Wisconsin experiments, whereas in the foregoing pages attention was called to the fact that the pigs fed narrow rations produced in two experiments more internal fat in proportion to live weight than similarly bred pigs on a wide ration. Here it must be noted that the wide-ration pigs produced 0.76 per cent more internal fat than those on the narrow ration. A point to be observed in connection with the Iowa experiments is that there was a very much greater variety of feed given than in the Wisconsin experiments, and that so far as variety of feed was concerned the conditions were practically the same for both lots now under consideration. In the first experiment the wide-ration pigs were given, during the feeding period of one hundred and fifty-three days, fourteen different feeds and the narrow-ration lot thirteen. In the second experiment the wide-ration pigs had, during a feeding period of one hundred and sixty-four days, nine different feeds, and those on the narrow ration ten. In the Wisconsin experiments the narrow-ration pigs that showed the greatest variation in relative weights of blood and vital organs compared with those on a wide ration, in the same test, received for one hundred and twenty-six days a ration of ground pease, wheat middlings, and skim milk, while the wide-ration pigs had corn meal and skim milk. In the other experiments neither lot was given an advantage in variety and two kinds of feed to each lot was the most allowed, the same feeds being given during the entire experiment.

In discussing results the Wisconsin Station investigators[a] point out that the pigs on wide rations generally dressed a larger percentage of the live weight than those on narrow rations, but that this larger relative amount of dressed weight was made at the expense of the weight of vital organs. Conversely, the greater weight of vital organs of the narrow-ration pigs was made at the expense of the dressed weight. The following comments on the Wisconsin results are interesting:

> It may be noticed that in the amount of blood, weight of intestines, and stomach, weight of livers, and weight of kidneys, the pea-fed lot has a greater average weight in every case than the corn-fed lot; and, as this is generally considered as

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[a] Seventeenth An. Rpt., pp. 21–23.

comprising the most of the material making up the difference between dressed and live weight, the question naturally arises as to why there should not be a greater difference than the table shows in the average percentage of dressed meat to live weight between the two lots. This may be explained by stating that in dressing the carcasses of the two lots it was noticed that there was apparently somewhat of a "dropsical" condition in nearly all of the pigs of the corn-fed lot; i. e., there was quite a large quantity of fluid in the abdominal cavity, which was not to be found, in such quantities at least, in those fed on pease and middlings.

The following quotation suggests the possibility that long-continued feeding exclusively on a very wide ration, such as corn, may lower vitality and render the animal less able to resist disease:[a]

Further study of the table discloses the fact that this increased percentage of dressed meat to live weight is the outcome of a proportionately smaller percentage of blood and heart, kidneys, liver, spleen, stomach, intestines, and other internal organs that have to do with the vital functions of the animal. It may be that this increased percentage of dressed meat has been secured at the expense of the vitalizing forces of the animal, leaving it impoverished in those respects to a degree that may go far to explain the great prevalence of hog cholera and other diseases that are so common and so extremely fatal in those sections where the hogs are fed mainly corn.

INFLUENCE OF TANKAGE ON THE CARCASS.

When the Indiana experiments with tankage closed, 2 pigs in each lot were slaughtered and the various parts of the body weighed.[b] The expected difference in weight of vital organs of the tankage-fed hogs as compared with those fed on corn was not very apparent. A corn-fed pig weighing 182 pounds yielded 4½ pounds of blood, which was the same as that of a pig weighing 195 pounds fed the smaller tankage ration (Lot I) and only 2 ounces more than a 150-pound pig from the lot fed on corn meal, shorts, and tankage. There was no difference in either weight or length of small intestines due to feeding the highly nitrogenous feed. The pig showing the greatest length of small intestines (65 feet 4 inches) was fed on corn, the next greatest length of small intestine being 60½ feet from a tankage-fed pig. The only difference in the digestive organs that could be charged to the feed was the condition of the stomachs in the corn-fed lot. These were filled with "sour, offensive-smelling corn meal," and the contents of one of them weighed 11 pounds 4 ounces, while the next greater weight of stomach contents was 6 pounds 5 ounces, found in the case of a pig on corn meal, shorts, and tankage. This apparently sour, abnormal condition of the contents of the stomachs was not particularly marked with the tankage-fed pigs.

When the carcasses were cooled and cut up, the only appreciable difference that could be traced to the feed was a somewhat greater accumulation of internal fat in the corn-fed pigs, and the flesh was somewhat less firm than that of the tankage-fed carcasses. Feeding tankage did not show a marked influence on the relative amount of lean meat, but this feature was very plainly influenced by the breed. Half the pigs were Berkshires and half Poland Chinas. The Berkshire carcasses showed relatively more lean meat than the Poland China carcasses, and in every instance the depth of fat on the back was less in the carcasses of the Berkshires than in those of the Poland Chinas.

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[a] Eighteenth An. Rpt., p. 33, Wisconsin Expt. Sta.

[b] Bul. No. 90, Indiana Expt. Sta.

INFLUENCE OF FEED ON EXTERIOR FAT.

The preceding figures show mainly the influence of feed on the internal organs. The following show the effect of various rations as evidenced by the thickness of fat on the loin, back, and shoulders. These results were obtained at the Wisconsin Experiment Station[a] in connection with slaughter tests already noted:

Thickness of exterior fat of pigs fed wide and narrow rations.

Ration and breeding.	Loin.	Back.	Shoulder.
	Inches.	*Inches.*	*Inches.*
Corn and rye meals:			
Poland China	1.75	2.5	2.75
Yorkshire	1.37	1.5	2.25
Berkshire	1.75	2.12	2.37
Razorback-Poland China	1.75	2.5	3.00
Do	1.12	2.0	2.12
Average	1.54	2.12	2.49
Pea meal and shorts:			
Berkshire	1.25	1.62	1.75
Poland China	1.37	1.75	2.12
Razorback-Poland China	.88	1.62	2.00
Do	1.25	1.75	2.00
Average	1.16	1.68	1.96
Pea meal:			
Razorback-Berkshire	1.5	1.625	2.00
Small Yorkshire	1.375	1.875	2.75
Razorback	1.875	2.0	1.375
Razorback-Poland China	2.0	2.0	3.00
Razorback	2.25	2.375	2.75
Average	1.8	1.975	2.175
Corn meal:			
Razorback	2.0	2.125	3.00
Do	1.125	1.25	1.75
Small Yorkshire	2.125	2.125	3.00
Razorback-Poland China	3.00	2.75	3.50
Razorback-Berkshire	1.75	2.0	2.50
Average	2.0	2.05	2.55

[a] Eighteenth An. Rpt.

The following table presents the averages of the foregoing:

Average thickness of exterior fat of pigs fed wide and narrow rations.

Ration.	Loin.	Back.	Shoulder.
Wide ration:	*Inches.*	*Inches.*	*Inches.*
Corn and rye meals	1.54	2.12	2.49
Corn meal	2.00	2.05	2.55
Narrow ration:			
Pea meal and shorts	1.16	1.68	1.96
Pea meal	1.8	1.975	2.175

The influence of these rations on the exterior fat is very marked. In each case where a narrow ration was fed, the fat of the loin, back, and shoulder was less than where a wide ration was fed. To go more into details, where pea meal and shorts were fed in comparison with corn meal and rye meal, the thickness of fat on the loin, back, and shoulder was 1.16 inches, 1.68 inches, and 1.96 inches, respectively, in the pigs fed on the narrow ration; and the same measurements of the pigs fed corn meal and rye meal were 1.54 inches, 2.12 inches, and 2.49 inches, respectively. The difference in thickness of fat between the pigs fed pea meal in comparison with corn meal was not so great as in the other experiment. The thickness of loin, back, and shoulders of the pea-fed pigs was 1.8 inches, 1.975 inches, and 2.175 inches, respectively—considerably more in all cases than those measurements for the pigs on pea meal and shorts, although the nutritive ratio of the pease was less than that of the ration of pea meal and shorts. These measurements of the pigs fed corn meal were, respectively, 2 inches, 2.05 inches, and 2.55 inches. Although there was an excess over the pigs fed corn meal and rye meal, except in the thickness of fat on the back, the difference in these measurements between the pigs fed corn meal and those fed pea meal is less in all respects than the same measurements between the pigs fed corn meal and rye meal and those fed pea meal and shorts.

The respective influences of breed and feed are very well marked, as shown in the large table. As an example of the predominance of breed influence, the Yorkshire in the lot fed corn meal and rye meal and the Poland China in the lot on pea meal and shorts are interesting. The Yorkshire had a thickness of fat over loin, back, and shoulder of 1.37 inches, 1.5 inches, and 2.25 inches, respectively—considerably below the average for the lot; the Poland China in the narrow-ration lot measured 1.37 inches, 1.75 inches, and 2.12 inches, respectively, at these points—considerably above the average of the lot. On the other hand, a very interesting instance of the predominance of the influence of feed is seen in the case of the small Yorkshire in the lot fed corn meal, which measured 2.125 inches, 2.125 inches, and 3 inches, respectively, over loin, back, and shoulder, standing second in the lot in this respect and well above the average.

EFFECT OF FEED ON STRENGTH OF BONES.

In the two experiments[a], of which the foregoing results are a part, tests were made to ascertain the breaking strength of thigh and hind pastern bones and the influence of different means of feeding on this. The following results were obtained:

Breaking strength of bones.

Ration and breeding.	Thigh.	Hind pastern.
Corn and rye meals:	*Pounds.*	*Pounds.*
Poland China	930.0	232.0
Yorkshire	886.0	175.0
Berkshire	748.0	277.0
Razorback-Poland China	1,050.0	384.0
Do	727.0	204.0
Average	868.0	254.0
Corn meal:		
Razorback	456.0	234.0
Razorback	610.0	170.0
Yorkshire	720.0	248.0
Razorback-Poland China	1,027.0	273.0
Razorback-Berkshire	583.0	219.0
Average	679.2	242.0
Pea meal and shorts:		
Berkshire	816.0	274.0
Poland China	862.0	240.0
Razorback-Poland China	762.0	174.0
Do	859.0	306.0
Average	829.0	249.0
Pea meal:		
Razorback-Berkshire	642.0	375.0
Yorkshire	791.0	370.0
Razorback	793.0	360.0
Razorback-Poland China	1,260.0	343.0
Razorback	823.0	340.0
Average	861.8	357.6

These figures show a greater breaking strength of thigh and hind pastern bones in the wide-ration pigs fed on corn and rye meals than those fed otherwise. In the experiment with pea meal and corn meal, however, the breaking strength of these bones was much higher in the narrow-ration lot than in those fattened on a wide ration.

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[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

Carlyle and McConnell[a] calculated the breaking strength of the bones for each 100 pounds of carcass weight, and their results are given in the following table:

Breaking strength of bones per 100 pounds carcass weight.

Ration.	Thigh.	Hind pastern.
	Pounds.	*Pounds.*
Corn and rye meals	504.0	146.0
Corn meal	530.4	180.2
Pea meal and shorts	568	169
Pea meal	579.4	245.2

When we consider the breaking strength of the bones in relation to the weight of carcass, there is a very manifest advantage in favor of the narrow ration, the bones of the pigs on pea meal alone breaking at a higher point than those of the pigs on pea meal and shorts, and the bones of the pigs on corn meal alone breaking at a higher point than those of the pigs on corn meal and rye meal.

FEEDING FOR PRIME BACON.

One of the branches of the hog industry to which it would seem profitable for farmers in the United States to pay more attention than in the past is the production of bacon for the English market. Most United States export product goes to Great Britain, and it forms the greater part of the bacon imported by that country, but it has never equaled the Danish bacon in price, and in this respect it has generally been behind the bacon imported from Canada also. While American bacon is said to have a better standing on this market at present than in former years, we can hardly yet claim superiority for it; and whatever advance in quality has been made must be attributed rather to the enterprise of the packers than to increased skill on the part of the breeder or the feeder.

Canadian farmers depend upon their exports of bacon to a very great extent, and its maintenance is a source of solicitude. Day, at the Ontario Agricultural College, and Grisdale and Shutt, at the Central Experiment Farm, have studied the production of export bacon during the past eight years to ascertain the best methods of feeding and breeding, and also the prevention of deleterious properties in the bacon produced.

REQUIREMENTS OF THE ENGLISH BACON TRADE.

At the outset of his studies Day[b] obtained data concerning the requirements of packers for the bacon exported to Great Britain.

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[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

[b] An. Rpt., 1896, pp. 74–77, Ontario Agricultural College.

The following statement from J. W. Flavelle, of Toronto, an authority on this subject, explains these requirements and the qualifications of different breeds to meet them, according to the information at the time of writing:

> The English market for Wiltshire sides is in a general way divided, first in relation to the fatness or leanness of a side, and second as to its size.
>
> The most desirable hog is one which will make a side weighing from 42 pounds to 55 pounds. If it be made from a hog with the fat even down the back, and not too much of it, and a good thick belly, it will grade as No. 1 selection. If the back be too stout, with perhaps only the extra fat bowed up on the shoulder, it may go into what we call No. 2 selection. This No. 2 selection is purely regulated by the fatness of the side. If it is extra stout, it goes forward as "fat." The value of a No. 2 side fluctuates very greatly. Sometimes, when the market is in a peculiarly active condition, No. 2 sides will sell almost on a parity with No. 1. The greatest difference is from 2 to 8 shillings, with perhaps an average through the year of 4 shillings per hundredweight. Heavier sides weighing, say from 60 pounds to 70 pounds, even if lean, often bear a severe reduction in price, while if they are fat we have known the difference to reach the extreme point of 12 shillings per hundredweight, although this, of course, is a very rare case.[a]
>
> * * * * * * *
>
> The value of hogs, like your Chester White, Duroc Jersey, and Poland China, is largely determined by the season of the year in which they are marketed. The sections from which these come the most freely (Essex and Kent) have always catered to the dressed-hog trade and have been in the habit, prior to eighteen months ago [about 1895], of marketing their hogs almost exclusively during the winter months. These hogs were marketed at a time when the export business was the worst—the winter trade always recording lower prices in England than the summer, hence these hogs have sold for dressed-hog purposes fairly well up to desirable Wiltshire stock. We are, however, as exporters, gradually pulling away from them even in winter time, and to-day we are paying for prime lean hogs up to 200 pounds 4 cents, while for fat hogs, and hogs over 200 pounds, we are only paying 3½ cents.

Mr. Flavelle states, in reporting on the pigs of a breed test of 1896, that with the possible exception of 1 each of the Duroc Jersey, Poland China, and Chester White breeds, all the pigs of these breeds would go into the 3½-cent class. These 3 were excepted on account of being "sizable," "showing some evidence of flesh," although, strictly speaking, they would be thrown out. One Yorkshire and 2 Berkshires would go into the 3½-cent class. The Tamworths were all classed as No. 1 selection, but one was faulty from being fed too long. He advises the development of a hog for the Canadian export trade which shall be well fleshed, deep in side, with a well-proportioned ham and shoulder, and marketed at a weight of 165 to 190 pounds. Care is advised to get an animal with a good thick belly, and one that will fatten evenly on the back and carry a side very even throughout. He states that the criticism to which Canadian sides are subject on

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[a] In a later report Day defines Wiltshire bacon as "made from well-fed hogs, weighing from 160 to 200 pounds live weight. 'Cumberland bacon' is made from lighter and generally leaner hogs, and the side is cut differently."—Ontario Agricultural College An. Rpt., 1898, p. 88.

English markets, when compared with Irish and Danish sides, is that the Canadian side "ran off in the loin and ham." There was too much shoulder development as compared with that of the ham.

SOFT BACON.

The greatest obstacle with which Canadian bacon curers have to contend is the tendency of the bacon to become soft in curing. The Canadian packer finds an "inordinate quantity of soft bacon" in the product of hogs purchased in May, June, and part of July.[a] The nature of this trouble, its causes and prevention, have been studied very extensively by Canadian experimenters. Day states that soft bacon does not necessarily mean fat bacon; on the contrary, softness is more likely to develop in hogs that are lean and underfed than in those that have been well fed and are fat. This statement is borne out by the report of the packer on the pigs fed in 1898 that the Cumberland sides in all lots showed more tendency to softness than the Wiltshires, although they were not of the same breed nor were they fed similarly.[b] Again the packer's report states:

> It was very noticeable that the sides which turned out soft invariably belonged to hogs that were manifestly unfinished. Without exception, the backs of the soft sides were thin (usually less than three-fourths of an inch in thickness) and in general pointed not so much to lack of weight, but rather to the hogs having been marketed before they were in a marketable condition. This is also true in a wider way according to our experience. The bulk of soft sides in our house come from No. 3 and No. 4 selection, which classes comprise the light weights.[c]

Day says:[a]

> Where the tenderness is barely noticeable, the bacon may still pass as No. 1 selection; when there is decided tenderness, it must go into a cheaper grade; but a really soft side is of little value.

According to Day—[a]

> Softness develops while the bacon is in the salt, and when taken out of the salt the fat is soft and spongy, the value of the bacon being reduced according to the degree of softness.

According to Shutt,[d] softness is readily perceptible to the touch and visibly noticeable when firm and soft sides are hung on the hooks, the "drag" of the soft sides being much greater than that of the firm ones. Its effects are also seen when firm and soft sides are lifted from a table by either end, the firm side remaining fairly straight and the soft one doubling over.

The nature of softness.—At the Central Experimental Farm, Shutt[e] conducted exhaustive studies during two years to study the nature, cause, and prevention of softness in bacon. He found that the soft characteristic was due to the presence of a large proportion of liquid fats, principally olein, in the fatty tissue of the pork. Animal fats are generally composed mainly of three fatty compounds—palmitin, stearin, and olein, of which olein constitutes the greatest part of the fat of swine. Of these, palmitin and stearin are solid at ordinary temperatures, but olein is a liquid or fluid fat at ordinary temperatures, and it is readily apparent that the greater the proportion of olein in fat the softer it will be, and, conversely, the greater the proportion of palmitin and stearin the firmer the fat will be.

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[a] An. Rpt., 1898, p. 88, Ontario Agricultural College.

[b] An. Rpt., 1898, Ontario Agricultural College.

[c] An. Rpt., 1901, p. 59, Ontario Agricultural College.

[d] Bul. No. 38, p. 8, Central Experimental Farm.

[e] Bul. No. 38.

The fatty tissues from 2 Wiltshire sides was analyzed; one was firm and of good quality, weighing 46 pounds, and the other, weighing 44 pounds, was soft and of very inferior quality. Samples were taken by cutting into the sides immediately in front of the thigh joint (socket of the femur in the pelvic arch) and immediately in front of the first rib, this being done to offset any possible differences in the composition of the fat due to its location; the one sample was designated "loin," the other "shoulder." The following table shows the composition of fatty tissue in these samples:

Composition of fatty tissue in firm and soft bacon. (*Shutt.*)

	Firm.		Soft.	
	Loin.	Shoulder.	Loin.	Shoulder.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	15.56	6.53	12.50	2.67
Salt	2.78	1.12	1.84	.48
Nitrogen	.504	.285	.243	.142
Fiber (nitrogenous matter)	3.15	1.78	1.52	.89
Fat	78.56	90.57	84.27	95.96
Olein in bacon	50.05	58.33	66.37	76.94
Palmitin and stearin in bacon	28.51	32.24	17.90	19.02

The term "olein" used in these experiments includes not only olein, but all fluid fats present in the fatty tissue of the pork analyzed. As the final effect of all fluid fats on the consistency of the fatty tissue was held to be similar, this method rendered the calculations much less complex. To show the relative amounts of fluid to solid fats, the pure fats were analyzed and the ratio of solid to fluid fats calculated, with the results shown in the following table:

Composition of fat from firm and soft bacon. (*Shutt.*)

	Firm.		Soft.	
	Loin.	Shoulder.	Loin.	Shoulder.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Olein (calculated)	63.71	64.40	79.95	80.18
Palmitin and stearin	36.29	35.60	20.05	19.82
Ratio of palmitin and stearin to olein	1:1.76	1:1.80	1:3.99	1:4.02

These figures show a much larger percentage of olein in the firm pork than in the soft, being about 64 per cent in the former and 80 per cent in the latter. The greater amount of olein in the soft pork is accompanied by a corresponding decrease in the relative amount of palmitin and stearin present. The proportion of the solid to fluid fats was about 1:1.78 in the firm side and 1:4 in the soft side. Shutt[a] ascribes the cause of soft pork to this large proportion of fluid fats, and uses the estimation of the olein as "a ready means of tracing the effect of any particular food or condition on the pork produced."

The following table shows physical and chemical constants of the fat from firm and soft bacon:

Physical and chemical constants of fat from firm and soft bacon. (*Shutt.*)

	Firm.		Soft.	
	Loin.	Shoulder.	Loin.	Shoulder.
Melting point	37.6° C.	37.75° C.	27.4° C.	28.2° C.
Specific gravity at 98° C	.8668	.8859	.8678	.8740
Specific gravity at 100° F	.9009	.8980	.8970	.8988
Saponification equivalent	285.3	282.3	287.3	286
Reichert number	.408	.714	.408	.663
Iodine absorbed	55.3	55.9	69.4	69.6

Standards of firmness.—As no investigation of this nature could be carried on without standards of excellence for the bacon analyzed, a tentative scale was agreed upon. A factory standard was adopted ranging from 100 downward. The quality of the bacon was determined by feeling and running the finger down the fat surface of the back of a cut side, the "hardest and most resistant to pressure" being rated at 100.[b] Oiliness was particularly noted, and it is stated that "there were but few cases in which the softness (slight resistance to pressure) was not accompanied with this quality."[c] Thickness of fat and shape of carcass were also considered in making the factory ratings. The factory scale was as follows:

Very firm	85 to 100
Firm	75 to 85
Moderately firm	70 to 75
Soft	50 to 70
Very soft	less than 50

There were many objections to the use of the factory rating as the sole means of determining the amount of softness. The ratings were not so accurate, for many reasons, as was desired. The element of error in calculation, the effect of low temperatures in winter (when artificial refrigeration is unnecessary at Ottawa), making the pork appear firmer than it really was, and of high temperatures in summer, making the bacon appear softer than it really was, led to the use of the olein content as the principal means of rating the softness of the pork. Unless the greatest care is taken in making the factory ratings, Shutt regards them "of little save corroborative value."[a]

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[a] Bul. No. 38, p. 9, Central Experimental Farm.

[b] Bul. No. 38, p. 11, Central Experimental Farm.

[c] Loc. cit.

The approximate percentages of olein corresponding to the factory ratings are given as follows:

	Percentage of olein.
Very firm	68 or less
Firm	68 to 71
Moderately firm	71 to 73
Soft	73 to 75
Very soft	75 and above

The greater accuracy of the olein content as the indicator of softness is shown by the fact that on factory inspection carcasses were frequently rated as "very firm" and "firm" that were shown by the olein content to be "soft" and "very soft." On the other hand, very few carcasses were rated lower by the factory inspection than by the determination of olein present.[b] In his discussion of the second series of experiments, Shutt states that "very frequently examination after smoking the bacon has confirmed the lower olein values."[c]

THE CAUSE OF SOFT PORK.

There have been many theories as to the cause of soft pork. It has been ascribed to breed, feed, age of the pig, the exercise allowed, the section of the country in which the pig is raised, the season of the year when slaughtered, etc. Shutt[b] states:

> Many theories have been advanced to account for softness in pork. Some have ascribed it to the character of the food, others to undue forcing of the pig in the earlier stages of growth, to killing the pig while in heat, to slaughtering while still immature, or unripe, to the breed of the pig, to the locality or district in which the pig is grown, and even the phase of the moon when the pig is slaughtered has been assigned as a cause.

Of all these influences, the ones that have been especially investigated have been maturity of the animals, the character of the feed and its methods of preparation, exercise, locality where produced, and breed.

Day's[d] investigations soon showed that the influence of breed was of little or no consequence. Firm bacon from pigs of the lard type and soft bacon from pigs of the bacon type showed that, so far as the firmness of bacon was concerned, methods of feeding and management were of more importance than the question of breed. Experimenters studying the causes of soft pork are therefore disregarding the breed question to a certain extent and are only taking pains to select animals that are of pronounced bacon type. At the Ontario Agricultural College, Day fed pigs on various rations to study the effect of feed and exercise on the firmness of bacon.

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[a] Bul. No. 38, p. 11, Central Experimental Farm.

[b] Bul. No. 38, p. 12, Central Experimental Farm.

[c] Bul. No. 38, p. 32, Central Experimental Farm.

[d] The reader should observe that the relative firmness of a side of bacon has little or nothing to do with the relative amount of lean meat and fat. The latter factor is undoubtedly the result of breed influence to some extent.

At the Central Experimental Farm, Shutt's investigations covered two years. In the first year's work, about 180 Tamworth or Tamworth grade pigs were fed, the experiment commencing in May, 1899, when the pigs were one to two months old, and closing May 28, 1900. The work of this year was devoted to the effect of character and preparation of feed and methods of feeding, maturity at slaughtering, exercise, and locality where raised. Twenty lots were fed, in six of which the feeding was divided into two periods, the first period including the feeding until the pigs had attained a weight of 100 pounds and the second period included feeding after that weight. This was done to ascertain the effects of different rations at various stages of growth, as it was thought that feeding in the earlier stages a ration that was supposed to have a beneficial effect might mitigate the effects during the latter part of the fattening of one that was known to be injurious, and, conversely, to ascertain whether a beneficial ration fed to pigs during the latter stages of the experiment would offset the injurious effect of an earlier feed. This was proceeding on the theory that Day used when he fed pigs skim milk up to a weight of about 100 pounds, or allowed exercise, and discontinued such treatment after attaining this weight, and vice versa. The methods of studying the effects of immaturity and the results therefrom have already been given. To study the effects of exercise, the animals on each ration were divided into two lots, one being "in small paddocks containing shanties or shelters," the other "in a pen of the piggery, each pen having a small yard attached." To study the effect of locality on quality of bacon, half the pigs on all but three rations were from western Ontario (Essex and Kent counties) whence packers claimed to receive most of their soft bacon, and half were from eastern Ontario (Carleton County).

Each ration was given in both "limited" and "unlimited" amounts. "Where not otherwise stated, a sufficiency of green fodder, usually pease and oats, in addition to the grain ration, was given to keep the animals in a thrifty condition." This was done because it was generally recognized that these feeds induced a thrifty growth and that thrift during life has much to do with the quality of the bacon.

INFLUENCE OF MATURITY ON FIRMNESS OF BACON.

Day's conclusions on the influence of maturity on the firmness of bacon have been already referred to. Shutt's results on this phase of the subject follow. (See p. 208.) During the preliminary investigations 4 pigs that had been weaned but a short time were killed and the olein content and melting point ascertained. The following table shows these results:

Immature pork—composition and melting point. (Shutt.) [a]

Locality.	Dressed weight.	Olein.		Ratio of palmitin and stearin to olein.		Melting point.	
		Shoulder.	Loin.	Shoulder.	Loin.	Shoulder.	Loin.
	Pounds.	*Per cent.*	*Per cent.*			° *C.*	° *C.*
Western Ontario	27	90.6	88.2	1:9.6	1:7.5	25.2	24.4
Do	23	86.9	85.9	1:6.5	1:6.1	24.5	25.7
Eastern Ontario	42	83.3	82.2	1:4.9	1:4.6	27.6	28.5
Do	30	73.8	72.9	1:2.7	1:2.7	29.8	32.0

[a] Bul. No. 33, p. 10, Central Experimental Farm.

Comparing these results with those of the firm pork (p. 209), this immature pork is seen to be much higher in olein content, the ratio of palmitin and stearin to olein less, and the melting point lower. It was regarded as noteworthy that the showing of the pigs from eastern Ontario was much better than those from the western counties.

As one phase of his work in 1899, the first year of his investigations, Shutt killed 2 pigs in each lot when they had attained a weight of 100 pounds and examined them for olein content and melting point of fat, thus obtaining more complete data on the effect of immaturity on the firmness of the bacon produced. "Maturity" was considered to be a weight of 175 to 200 pounds. The following table shows these results:

Relative amount of olein [a] *in fat of immature pigs. (Shutt.)* [b]

Ration.	Eastern.	Western.	Mean.
	Per cent.	*Per cent.*	*Per cent.*
Corn meal ½, oats, pease, and barley equal parts ½; boiled; unlimited	[c] 77.1	[c] 91.6	84.3
Corn meal, oats ½, pease, and barley equal parts ½; boiled; limited	79.2		
Corn meal ½, oats, pease, and barley equal parts ½; dry; unlimited	83	87.1	85
Corn meal ½, oats, pease, and barley equal parts ½; dry; limited	75	83.5	79.3
Corn meal; dry; unlimited	87.2	85.6	86.4
Oats, pease, and barley, equal parts; dry; unlimited	80.9	83.6	82.1
Corn meal; soaked; unlimited	85.7	88.4	87
Oats, pease, and barley, equal parts; soaked; unlimited	71.9	77	74.4
Beans 1 part, shorts ½ part	[c] 83.9		

[a] As the fat from shoulder and loin differed so little in olein content, the results of the analyses of the fat from these points were averaged.

[b] Bul. No. 33, p. 16, Central Experimental Farm.

[c] One pig only.

These results also show much higher figures for young pigs than have already been noted as characteristic of firm pork. The difference is very pronounced. The analysis of firm bacon gave the relative amount of olein as about 64 per cent. Here the smallest amount of olein is 71.9 per cent in the case of eastern Ontario pigs which were fed an unlimited ration of equal parts of oats, pease, and barley, soaked. The high olein content of the pigs fed corn and beans should be noted, as should also that of the pigs from western Ontario. Shutt[a] regards these results as furnishing "undoubted proof of the soft character of the fat of young pigs."

INFLUENCE OF FEED AND MANAGEMENT ON THE FIRMNESS OF BACON.

RESULTS AT GUELPH.

The following table shows Day's[b] results in studying, in 1898, the influence of feed and management on the firmness of bacon. It includes results with pigs on various feeds and fed under various conditions. The factors studied were the kind of feed, method of feeding, and exercise. The pigs in the first three groups were purchased in September, and had been running on a stubble field for about six weeks. Groups IV, V, and VI were kept in pens from the time of weaning. The pigs of the last three lots were purebreds that had been in an experiment designed to show the effects of whey and exercise. After the pigs were slaughtered, packing-house inspections of the bacon were made, and these reports are included in the last column of the following table:

Condition of bacon produced by various methods of feeding.

Description of groups and methods of feeding.	Condition of bacon.
Group I: 8 sides. Hogs had been running on stubble fields. Average weight at commencement of experiment, 118 pounds. Fed six weeks on corn meal and rape.	Wiltshires: 8 sides firm.
Group II: 8 sides. Same previous treatment as Group I. Average weight at beginning of experiment, 107 pounds. Fed six weeks on corn meal.	Wiltshires: 6 sides firm. Cumberlands: 2 sides firm.
Group III: 8 sides. Same previous treatment as Group I. Average weight at beginning of experiment, 104 pounds. Fed six weeks on pease, barley, and shorts.	Wiltshires: 4 sides firm. Cumberlands: 2 sides firm, 2 sides tender.
Group IV: 8 sides. Hogs had no outdoor exercise from time of weaning. Previous to experiment were fed wheat middlings and shorts, with skimmed milk. Average weight at beginning of experiment, 100 pounds. Fed six weeks on pease, barley, and shorts, with rape.	Wiltshires: 2 sides firm, 2 sides showing very slight indications of tenderness. Cumberlands: 2 sides firm, 2 sides soft.
Group V: 8 sides. Same treatment previous to experiment as Group IV. Average weight at beginning of experiment, 94 pounds. Fed six weeks on corn meal.	Wiltshires: 2 sides firm. Cumberlands: 6 sides firm.
Group VI: 6 sides. Same treatment previous to experiment as Group IV. Average weight at beginning of experiment, 107 pounds. Fed six weeks on pease, barley, and shorts.	Wiltshires: 2 sides firm. Cumberlands: 4 sides firm.

[a] Bul. No. 38, p. 17, Central Experimental Farm.

[b] An. Rpt., 1898, Ontario Agricultural College.

Condition of bacon produced by various methods of feeding—Continued.

Description of groups and methods of feeding.	Condition of bacon.
Group A: 24 sides. Purebred hogs, comprising 2 hogs of each of six different breeds. Purchased when from seven to nine weeks old. Kept in pens with small outside yards. Fed wheat middlings until August 19; shorts and barley until September 12; pease, barley, and shorts until October 24.	Wiltshires: 4 sides firm, 2 sides showing indication to tenderness, 2 sides tender, 2 sides soft. Cumberlands: 4 sides firm, 8 sides tender to soft.
Group B: 24 sides. Same as Group A. Same treatment and same meal ration as Group A, but fed whey with meal ration.	Wiltshires: 20 sides firm. Cumberlands: 2 sides firm, 2 sides tender.
Group C: 22 sides. Same as Group A. Hogs were allowed to run in a half-acre lot during whole of experiment. Lot furnished some grass until about the middle of August. Fed the same ration as Group A.	Wiltshires: 10 sides firm, 2 sides very slightly tender. Cumberlands: 2 sides firm, 8 sides tender to soft. Quality of Group C much superior to that of Group A as regards firmness.

In discussing this table, Day calls attention to the condition of the bacon from the first three groups. These were the pigs that had had an abundance of exercise before feeding proper commenced. One lot had corn meal and rape, another corn meal only, and the third a mixed ration of pease, barley, and shorts. Yet the "only tenderness developed in the group fed on pease, barley, and shorts." With the pigs that had had no exercise after weaning (Groups IV, V, and VI) except what they obtained in the pens, the only tenderness in the bacon was in the pigs fed pease, barley, and shorts with rape. The cause of this is not apparent, as the lot on corn meal and rape made firm bacon. The suggestion is made that the lack of exercise may have had this result.

The condition of the bacon from Group B, as compared with Groups C and A, is particularly striking. It is pointed out that, although the pigs of Group B were closely confined, they made firmer bacon than those of Group C, which had an abundance of exercise and very much firmer bacon than those of Group A, which had moderate exercise. The difference is ascribed to the whey fed. The beneficial influence of dairy by-products in bacon production is seen when Groups IV, V, and VI are compared with Group A. These pigs had a ration of grain and skim milk prior to the beginning of the experimental feeding.

The influence of immaturity is seen in the larger proportion of soft sides in the Cumberlands than in the Wiltshires.

Influence of corn on bacon.—The effect of corn feeding in this experiment is decidedly unusual. Generally corn, when fed in large amounts, has produced undesirable bacon. The best results have come from mixed rations, in which barley was prominent. In a later experiment, Day[a] compared the bacon from pigs fed on corn, on pease and middlings, on barley, and on barley and rape. The packer reported on them as follows:

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[a] An. Rpt., 1899, p. 81, Ontario Agricultural College.

Lot I (corn): Very soft, fat, pasty, and greasy, and in every way undesirable. The hogs in this lot seem to have thrived well on the feed, as the sides are well finished, indeed quite fat.

Lot II (pease and middlings): Excellent quality, firm.

Lot III (barley): Very firm, probably the most distinctly hard and firm of any of the lots.

Lot IV (barley and rape): Good quality, firm, with a slight tendency, but very slight, toward tenderness.

The influence of barley on bacon.—Later experiments confirmed the evidence in favor of the use of barley for pigs. In 1900[a] several experiments were conducted with the end in view of comparing the effect of various feeds on the carcass.

In one experiment "the meal ration was as follows: Thirty-one days, 2 parts ground grain to 1 part middlings; forty-one days, 3 parts ground grain to 1 part middlings; remainder of time, or sixty-nine days, ground grain alone. The grain for one group consisted of equal parts of barley and corn, and for the other groups equal parts of barley and oats." The bacon made from these pigs was firm.

In another experiment barley and corn were compared. There were two lots of purebred pigs and they were fed as follows: "Twenty-four days, 1 part grain to 3 parts middlings; thirty-seven days, equal parts grain and middlings; remainder of time, or seventy-nine days, 3 parts grain to 1 of middlings." The bacon from 6 of the 7 hogs on barley and middlings was firm enough for No. 1 selection, 1 pig producing bacon too tender. None of the corn-fed pigs produced bacon firm enough for No. 1 selection.

Influence of roots on bacon.—Three lots of 5 pigs each were fed on meal alone, on meal and raw roots, and on meal and boiled roots. The meal that was fed was ground barley and middlings, and the test lasted one hundred and forty-one days, the meal consisting of 2 parts barley and 1 part middlings at first and changing gradually to clear barley, in the same manner as the pigs in the experiment with barley and corn and barley and oats in the preceding section. The ratio of meal to roots was about 1:1. The roots were discontinued three weeks before shipping the pigs to the packing house. The packer's report showed that all the bacon turned out firm.[a]

In another experiment 11 grade pigs that had been on roots, kitchen refuse, and mixed meal up to a weight of 120 pounds were fed meal and pulped mangels at the rate of 50 pounds of mangels to 22 pounds of meal for sixty-one days. The meal and mangels were mixed the day before feeding. The meal was 2 parts ground barley and 1 part of a mixture of bran and middlings. In this case the roots were fed up to the date of shipping without deleterious results, as all of the bacon cured in firm condition.[a]

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[a] An. Rpt., 1900, Ontario Agricultural College.

In the succeeding year raw pulped mangels were fed in rations of barley and middlings and of corn and middlings in about equal weight to that of meal fed. The feeding records of these experiments have already been reviewed. (See pp. 165–167.)

The following report of the packer shows that roots had no deleterious effect on the bacon:[b]

Barley and middlings: Eight sides, 2 of which were soft, the others grade as No. 1 sides, although there was noticeable in all a very slight tendency to pastiness.

Barley, middlings, and roots: Eight sides, 2 sides soft, 2 sides grading No. 2 (fat). The other 4 sides were very firm.

Corn and middlings: Ten sides; 4 sides tender, i. e., showing softness, but not so soft as to be excluded from No. 1 sides, 2 No. 2. The rest grade as No. 1 sides, although the class as a whole inclines to slight pastiness.

Corn, middlings, and roots: Ten sides, 4 sides soft, 2 grade as No. 2 sides. The balance were very firm.

RESULTS AT OTTAWA.

Grisdale[c] reports experiments at the Central Experimental Farm which were planned to determine the causes of soft pork, and found that the use of mixed rations generally gave the best results. In his first experiment one lot received a mixture of equal parts by measure of ground barley, rye, wheat, and wheat bran; a second, ground wheat, and a third ground buckwheat. All grain was soaked in cold water for an average period of thirty hours. The report of the packers was favorable to the carcasses of the mixed-ration lot, both immediately after cooling and when cured, the wheat-fed lot ranked second and that fed on buckwheat was least desirable. Some sides, however, were soft in the mixed-ration lot and some from the others were firm.

To determine still further the effect of wheat or buckwheat in the ration on the quality of the finished product, one lot was fed a mixture of equal parts by measure of ground barley, rye, wheat, and wheat bran, two on a ration composed of equal parts by weight of this mixture and ground wheat, while the other lot had a similar ration, buckwheat replacing the wheat. All meal was soaked thirty hours in cold water. The buyer and curer reported no difference in the quality of the pork from these lots, from which it would seem that feeding a mixed ration will produce a better quality of bacon than feeding a single grain. This conclusion is also borne out by the results of the feeding of 44 hogs with various rations—single grains, mixtures, with and without milk, dry and soaked, whole and ground. The report of the packer pointed to the value of milk in connection with a single grain, such as corn, and the beneficial effect of a mixture of grains, especially when one of them was barley.

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[a] An. Rpt., 1900, Ontario Agricultural College.

[b] An. Rpt., 1901, Ontario Agricultural College.

[c] Bul. No. 33, Central Experimental Farm.

CHEMICAL STUDIES AT OTTAWA.

FIRST SERIES OF EXPERIMENTS.—The following table shows Shutt's[a] averages of results during the first series of tests. The table shows the composition of the ration, the olein content, and the melting point of fat, the averages of these determinations for fat from loin and shoulder being given, as there was found to be very little difference in the characteristics of the fatty tissues from these points in these respects. The rations are arranged from above downward in order of olein content, those showing the least olein in the fat examined being at the top of the table and those showing most olein at the bottom.

It is stated that, as a rule, each pen contained 16 pigs at the start.

Effect of various rations on softness of pork.

[Averages from determinations of first series, 1899. (Shutt.)]

Ration.	Composition of ration.	Olein.	Melting point.
		Per cent.	°*C.*
F	Oats, pease, and barley, equal parts, soaked, unlimited	67.2	35.6
D	Oats, pease, and barley, equal parts, dry, unlimited	67 5	34.2
B	Corn meal ½, oats, pease, and barley equal parts ½, dry, unlimited	71.1	34.4
A	Corn meal ½, oats, pease, and barley equal parts ½, boiled, unlimited	72.7	33.6
B′	Corn meal ½, oats, pease, and barley equal parts ½, dry, limited	73.1	33.1
M	First period: Oats, pease, and barley, equal parts, soaked Second period: Corn meal, soaked	73.4	32.5
N	Corn meal ½, oats, pease, and barley equal parts ½, dry, limited	73.7	30.5
K	First period: Oats, pease, and barley equal parts, unlimited Second period: Corn meal, dry, unlimited	74.8	32.4
O	Corn meal ½, oats, pease, and barley equal parts ½, mangels	74.9	31.7
I	First period: Corn meal ½, oats, pease, and barley equal parts ½, dry, unlimited. Second period: Corn meal, dry	75.4	32.4
A′	Corn meal ½, oats, pease, and barley equal parts ½, boiled, limited	75.9	33.6
P	Corn meal ½, oats, pease, and barley equal parts ½, steamed clover	76.1	32.1
L	First period: Corn meal, soaked Second period: Oats, pease, and barley, equal parts, soaked	76.4	32.3
I′	First period: Corn meal ½, oats, pease, and barley equal parts ½, dry, limited. Second period: Corn meal, dry, limited	78.1	31.8
H	First period: Corn meal ½, oats, pease, and barley equal parts ½, boiled, unlimited. Second period: Corn meal, boiled, unlimited	77.9	33.0
J	First period: Corn meal, dry, unlimited Second period: Oats, pease, and barley, equal parts, dry, unlimited	78.8	31.3
H′	First period: Corn meal ½, oats, pease, and barley equal parts ½, boiled, limited. Second period: Corn meal, boiled, limited	80.0	30.2
G	Beans 1 part, shorts ¼ part	84.7	31.0
C	Corn meal, dry, unlimited	92.0	[b] 30.9
E	Corn meal, soaked, unlimited	92.4	27.7

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[a] Bul. No. 38, p. 15, Central Experimental Farm.

[b] Melting point average on 2 pigs only, as the fat of the others was so soft that the melting point could not be determined.

The effect of feed.—The most striking feature of these results is the good showing of a ration of equal parts of oats, pease, and barley. They were the only ration that produced pork with a sufficiently small amount of olein in the average to rank as "very firm." The carcasses from these pigs were generally firm and even in fat, the fat having a uniform thickness of about 1¼ inches. Growth was continuous and normal. The figures bear out Day's testimony in favor of a ration composed partly of barley, and the general advantage in feeding mixed rations is borne out by these results.

Corn-belt pork producers will be particularly interested in the results of the rations in which corn formed a considerable part. In rations B, A, and B′ it constituted half the grain that was fed, yet the olein content of the fat was 71.1 per cent with ration B and 73.7 per cent in the case of ration B′—not enough to prevent any of the carcasses of these three lots from averaging "firm." When corn meal was fed exclusively during one period of growth, a mixed ration being fed during the remaining time, better results were obtained where it was fed during the closing period than where it was fed during the first period, but the mitigating effect of a mixed ration following corn meal, during the early stages of the pig's growth, may be seen by comparing rations L and J with rations C and E. The olein content of these was 76.4 per cent and 78.8 per cent, respectively, with the former rations, and 92 per cent and 92.4 per cent, respectively, with the latter. However, Shutt[a] says: "Nevertheless, our data show conclusively that when the animal is fed to a weight of 100 pounds on corn exclusively, the corrective action of such an excellent ration as oats, pease, and barley is not sufficient to render the fat firm." He also mentions the oiliness of the fat from the pigs fed corn meal alone during the finishing period, which prevented the bacon from taking rank as first quality, although the fat averaged 3.5 per cent less olein than that from the pigs on corn during the first period.[b] The disadvantage of feeding corn meal exclusively during the entire feeding period, not only because of its effect on the quality of the bacon, but on account of its effect on the growth of the pigs, is very strongly emphasized. The olein content and melting point of the fat from these pigs was the lowest of any of the lots. In addition, it is stated that the pigs made very unsatisfactory growth. Few had reached a weight of 100 pounds at the age of seven months, and some scarcely exceeded that weight at eleven or twelve months; only 5 weighed more than 170 pounds when the experiment closed. The olein content of the fat was greatest in the "finished" pigs, the animals showing marked uniformity in this respect.[c] The packing-house inspection rated as "very soft" twenty-three of the carcasses fed on corn meal alone, and one as "soft." The meager and uneven covering of fat, its oily character, and the stunted appearance of many of the carcasses was particularly remarked upon. "In many instances the melting point could not be taken, owing to the fluidity of the fat."

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[a] Bul. No. 38, p. 24, Central Experimental Farm.

[b] Bul. No. 38, p. 25, Central Experimental Farm.

[c] Idem, p. 19.

The effect of a ration made up largely of beans is somewhat surprising. While the percentage of olein was considerably less and the melting point higher, the feeding value of this ration was quite similar to that of a straight corn ration, the growth being very unsatisfactory and the carcass lightly covered with fat that was very oily.[a]

Shutt calls attention to the rise in the percentage of olein when mangels were fed, but thinks this is "perhaps not to a degree sufficient to warrant any statement as to their effect on the pork." He states further: "Steamed clover, however, appeared to notably increase the olein. Very few of the carcasses from these rations fall into the classes of 'firm' and 'moderately firm,' the influences of the corn (forming half the grain ration) being apparent."

Effect of different conditions of feeding.—As already mentioned, these experiments considered not only the effect of the different feeds given, but the conditions under which they were fed. Those investigated were "the condition of the grain (soaked or dry), the locality or district in which the pigs were littered, and the amount of exercise obtainable." The plan of the experiments to study these conditions was outlined on page 212. The pigs fed rations N, O, and P were eastern Ontario pigs, and hence were not included in the following deductions; neither were the immature animals. The following is quoted:

> *Boiled as against dry grain.*—In the sets of experiments A and B, half corn meal and half oats, pease, and barley, boiled and dry, and I and H, first period, half corn meal and half oats, pease, and barley, boiled and dry, we find that the fat produced from the boiled grain in each case was the softer. In A and B the difference was 2.2 per cent olein, and in I and H the difference was 2.3 per cent olein.
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> *Soaked as against dry grain.*—This comparison was made with corn meal (C and E), a mixture of oats, pease, and barley (D and F), with rations employing during the first period corn meal, and second period oats, pease, and barley (J and H), and lastly, first period, oats, pease, and barley; second period, corn meal (K and M). The results are:
>
> *Percentages of olein.*

	C and E.	D and F.	J and H.	K and M.
Soaked	92.5	67.2	76.4	73.5
Dry	92.1	67.7	78.8	74.4

> We scarcely feel justified from these data in drawing any conclusions as to the relative effect on firmness of the same grain ration, fed soaked or dry. A study

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[a] Bul. No. 38, p. 22, Central Experimental Farm.

of the individual results does not reveal any definite tendency, and most probably the condition of the grain in this respect has but little, if any, effect on the quality of the pork.

Eastern origin as against western.—This feature was allowed for under all the rations tested.[a] The averages are in the order as discussed.

Percentages of olein.

	A and B.	C and E.	D and F.	I and H.	J and L.	K and M.
Eastern origin	73.4	91.2	67.9	78.6	76.4	74.4
Western origin	73.0	93.4	67.0	77.2	78.9	73.4

In four cases out of six, the olein of the eastern pigs is somewhat the greater, and taken together the averages give a total excess of 3.7 per cent olein over the corresponding western groups. In two cases the western pigs show the larger olein per cent, amounting to 4.7 per cent olein over the corresponding eastern groups. These facts do not warrant us in supposing that there is any marked tendency toward softness in finished pigs due simply to western origin, as is thought by some packers. If finished pigs from the western part of Ontario are softer than those from the eastern, it must be due to the character of the feed they obtain.

Inside as against outside.—As already explained, the pigs denoted as "inside" are held to have had opportunities for limited exercise only—that is, in the small yards attached to the pens of the piggery; the "outside" pigs had the run of an inclosure in which there was a movable sty or shelter for their accommodation at night.

The averages are as follows:

Percentages of olein.

	A and B.	C and E.	D and F.	I and H.	J and L.	K and M.
Inside	71.9	92.8	67.0	77.8	76.5	73.0
Outside	74.5	92.8	67.9	77.9	78.7	74.8

In several of these instances it will be seen the results are practically identical (for differences of less than 1 per cent must not be considered as forming a sufficiently strong basis from which to draw conclusions); in the other cases, the larger amount of olein appears in the fat of the "outside" pigs. There can be no doubt as to the value of a sufficiently large run for young and growing pigs; exercise to a limited extent in the earlier period of an animal's life is essential to a strong and thrifty growth, to good digestion and assimilation of the food.

We therefore do not think it wise, without further evidence, to draw the conclusion that the larger area of exercise had any injurious effects on the quality of the pork. Indeed, a survey of the two seasons' results makes it very clear that the character of the food is the one great influencing factor, and that the varying features or conditions, other than the ration, had very little to do with the relative firmness of the resulting fat.[b]

SECOND SERIES OF EXPERIMENTS.—In 1900 a second series of experiments was begun. All features relating to the effects of maturity and conditions of feeding were discontinued, because the bad effects of immaturity were regarded as proved, and the effects of conditions, such as boiling and soaking feed, origin, amount of ration and exercise, were regarded as of little importance. Many rations were duplicates of those of the preceding series and, in addition, the influences of skim milk and various succulent feeds were studied from various standpoints, as was also that of a ration of pease alone. As there had previously been found to be no important difference between the olein contents of the fatty tissue from the loin and the shoulder, the samples were taken from the shoulder only in this series of tests.

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[a] Except rations N, O, and P.—G. M. R.

[b] Bul. No. 38, pp. 26, 27, Central Experimental Farm.

The following table shows the averages of this series of experiments, arranged in the same manner as the preceding one:

Effect of various rations on softness of pork.

[Averages from determinations of second series, 1900. (Shutt.)]

Ration.	Composition of ration.	Olein.	Melting point.
		Per cent.	°*C.*
17 C	Corn meal ½, oats, pease, and barley, equal parts ½, skim milk and sugar beets	66.9	32.8
4	Pease	67.2	32.5
17 B	Corn meal ½, oats, pease, and barley, equal parts ½, skim milk and mangels	68.2	32.7
1	Oats, pease, and barley, equal parts	68.7	32.4
17 A	Corn meal ½, oats, pease, and barley, equal parts ½, skim milk and turnips	70.4	32.3
3	Corn meal and skim milk	70.9	33.3
7	Corn meal ½, oats, pease, and barley, equal parts ½, and skim milk	72.3	31.1
13	Corn meal ½, oats, pease, and barley, equal parts ½; from October 16, ½ corn meal, ½ pease	72.8	31.2
12	Corn meal ½, oats, pease, and barley, equal parts ½, and cooked pumpkins	73.3	31.4
14	Corn meal ½, oats, pease, barley ½, and artichokes	73.4	31.5
9	First period: Oats, pease, and barley, equal parts. Second period: Corn meal	73.9	31.1
11	First period: Pastured on rape; corn meal ½, oats, pease, and barley, equal parts ½. Second period: Raw pumpkins and same grain	74.2	31.6
6	Corn meal ½, oats, pease, and barley, equal parts ½	74.6	30.3
10	Pastured first on rape, finally on artichokes; corn meal ½, oats, pease, and barley, equal parts ½	74.9	31.4
16	First period: Corn meal. Second period: Oats, pease, and barley, equal parts	76.1	30.9
15	Pastured on clover; from October 30, fed clover; corn meal ½, oats, pease, and barley, equal parts ½	76.1	30.3
8	First period: Corn meal ½, oats, pease, and barley, equal parts ½. Second period: Corn meal	77.9	30.8
2	Corn meal only	83.6	28.6
5	Beans	84.9	29.5

The remarkable feature of these results is the good showing made by a ration in which skim milk formed a considerable part. Although corn meal made up half the amount of grain fed, the addition of skim milk and sugar beets gave this ration the firmest pork in the experiment. Rations A and B in the first series, which were the same without milk and roots, gave an average olein content of 73.2 per cent, which would grade the bacon as "soft," whereas the bacon from ration 17 C gave an olein content of only 66.9 per cent, grading "very firm." Shutt[a] is evidently not prepared to attribute a great amount of this difference to the use of succulent feeds, but rather regards the presence of roots as not detrimental. As ration 17 B in the second series and ration O in the first were identical, and as there was a difference of 6.7 per cent in olein content in favor of the skim milk ration, there are good grounds for attributing the greater influence to skim milk. The most remarkable corrective influence of this dairy by-product is seen when ration 3 (corn meal and skim milk) is compared with ration 2 (corn meal only). The advantage in olein content is 12.7 per cent in favor of the skim milk. Comparing rations 7 and 6, the corrective influence of skim milk when fed in a mixed grain ration is seen to be less than when corn meal alone makes up the grain of the ration. This result is similar to those obtained when studying the rate and economy of gain from various rations, and it would seem to indicate that variety in the ration is important as regards the firmness of the pork produced. These results show the same advantages in favor of feeding corn meal during the finishing period and mixed grain in the earlier stages, rather than feeding corn meal during the earlier months of life. (Compare rations 9 and 16.)

From the showing of the lots on roots, etc., Shutt[b] concludes that "rape, pumpkins, artichokes, sugar beets, turnips, and mangels can be fed in conjunction with a good ration without injuring the quality of the pork." With clover, however, he found a higher olein content than where no clover was fed, the percentage of olein being 76.1 in the first instance and 74.6 in the latter. (Compare rations 6 and 15.) He regards the fact that 76.1 per cent was the olein content of the pigs on ration P in the first series, which contained steamed clover, as emphasizing this opinion. The pigs on succulent feed showed a tendency to become too fat, particularly in the case of ration 10, where they had rape and artichokes.

A ration of equal parts of oats, pease, and barley proved very valuable, as in the first series; pease alone proved to have a very high feeding value, which was contrary to Day's experience but in line with that of the Wisconsin results. However, Day has found pease to produce a firm quality of bacon, but objects to them as a single feed for pigs, as his results do not show good gains with them alone. Beans again proved to be undesirable when fed without corrective feeds.

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[a] Bul. No. 38, p. 30, Central Experimental Farm.

[b] Bul. No. 38, p. 36, Central Experimental Farm.

FEEDING TO HARDEN THE FAT OF PORK.

A rather anomalous state of affairs exists in the fact that while authorities in Canada counsel feeders to refrain from very extensive use of corn in pig feeding, farmers in the South generally feed corn to harden the pork, and the investigations of the experiment stations seem to bear out this practice. It is said that when pigs are grazed on such feeds as chufas, peanuts, or other oily feeds, the pork made is extremely soft and oily and the lard more or less liquid. To counteract this, corn is fed during the latter part of the feeding period or as a large part of the ration during the entire time the pigs are on feed. Recently the effect of cotton-seed meal on the fat has been investigated with good results so far as increased firmness is concerned.

Effect of corn.—According to Bennett,[a] if good grade or purebred pigs are grazed on peanuts or chufas, either alone or combined, and if at the same time they are fed an amount of corn sufficient to full feed exclusively for four weeks, the quality of the pork and lard produced can not be distinguished in appearance from that of pigs fed on corn exclusively. Bennett[a] regards the use of more than this amount of corn as too expensive for the results obtained. He also reports that his results have shown that purebred pigs or good grades produce a firmer quality of pork and lard than scrubs. The range of individual variation in the melting point of lard from scrubs was much larger than that of the lard from grades and purebreds. Duggar,[b] however, states that in his experience, even when fed a month exclusively on corn, pigs formerly on peanuts made much more oily and soft pork and lard than hogs fed corn throughout the entire feeding period. This condition was noticeable even after cooking. "One month of exclusive corn feeding increased the firmness of pork made from animals previously fed on peanuts alone, but the improvement was not sufficient to make the flesh or the lard as firm as the same articles afforded by animals fed entirely on corn." Both Bennett and Duggar state that while exclusive peanut feeding injures the sale of lard and pork by making it soft and oily the cooking quality does not seem to be impaired.

As parts of the grazing experiments already noted Bennett determined the effect of the feeds on the melting point of the lard. The following table shows the averages of his results for three years. Regarding the determination of the melting point Bennett[c] says: "The figures reported for each pig (back and kidney) are the averages of four determinations of each sample of lard previously rendered from samples of fat. The back fat was taken from one side of each pig, in a strip extending from a point over the kidneys to the thin edge of the side."

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[a] Bul. No. 65, Arkansas Expt. Sta.

[b] Bul. No. 93, Alabama Expt. Sta.

[c] Bul. No. 65, p. 103, Arkansas Expt. Sta.

Average melting point of lard from pigs on different feed.

Year.	Feed.	Number of pigs.	Average melting point.			
			Back.		Kidney.	
			°*C.*	°*F.*	°*C.*	°*F.*
1898..	Grazed on peanuts, chufas, and soy beans without corn	7			37.0	98.6
	Grazed as above, followed by corn feeding ten days	4			34.2	93.6
	Fed corn exclusively	3			43.8	110.8
1899..	Grazed on peanuts and chufas without corn to harden the lard	10	22.9	73.2	31.2	88.2
	Grazed as above, with corn to harden the lard	6	26.3	79.3	34.1	93.4
1900..	Grazed on peanuts and chufas with corn	12	33.1	91.6	38.4	101.1
	Grazed as above, followed by corn feeding	8	32.5	90.5	37.8	100.0

Duggar[a] reports similar tests from the pigs in the Alabama experiments already mentioned. The melting points of lard from pigs fed in various ways were as follows:

Effect of corn on melting point of lard.

Ration.	Number of pigs.	Kind of lard.	Melting point of lard.	
			°*F.*	°*C.*
Corn	2	Leaf and body lard	111.2	44.0
Peanuts ½, corn ½	1	do	104.1	40.5
Peanuts	1	do	76.1	24.5

The following table shows the results of a test Duggar[b] conducted to determine the effects of feeding on corn alone after peanut feeding. The hogs had corn exclusively for one month before slaughtering:

Effect of corn on melting point of lard.

Ration previous to one month before butchering.	Melting point of lard.	
	°*F.*	°*C.*
Peanuts ½, corn ½	98.6	37.0
Peanuts	101.3	38.5

By comparing these figures with those immediately preceding, the effect of the corn feeding on the lot formerly on peanuts is apparent, but exclusive corn feeding had no appreciable effect on hogs that had formerly been on a ration consisting in part of corn. Bennett reached the same results at Arkansas. In his experiment of 1900 there is very little difference in melting point between hogs fed corn while grazing peanuts and those having corn after grazing.

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[a] Bul. No. 93, Alabama Expt. Sta.

[b] Idem.

The effect of cowpeas and corn.—Duggar[a] has reported a number of additional experiments to study the hardening effect of various methods of feeding and different rations. Where a pig that was fed a ration of one-third ground cowpeas and two-thirds corn meal was compared with pigs which had grazed sorghum, peanuts, or chufas, with and without grain, the melting point of the fat of the jowl was determined as follows:

Effect of cowpeas and corn on the firmness of lard.

Feed during 26 days before butchering.	Feed prior to 26 days before butchering.	Melting point of fat.	
		° *C.*	° *F.*
Cowpea meal ⅓, corn meal ⅔; peanuts	Cowpea meal ⅓, corn ⅔; grazed sorghum.	28.0	82.4
Peanuts alone	Peanuts; grazed sorghum	22.0	71.6
Cowpea meal ⅓, corn meal ⅔; chufas	Grazed cowpeas	27.5	81.5
Cowpea meal ⅓, corn meal ⅔	Cowpea meal ⅓, corn ⅔	30.0	87.0

The softening effect of an exclusive peanut ration and the hardening effect of the ration of ground cowpeas and corn are manifest from the above table.

The effect of cotton-seed meal.—Pigs which had received the same previous treatment as the last three lots in the foregoing table were placed on a ration of cotton-seed meal one-fourth, corn meal three-fourths, for thirty-five days.[a] The melting point of the body fat was determined as follows:

Effect of cotton-seed meal on the firmness of lard.

Feed during 35 days before butchering.	Feed second month before butchering.	Melting point of fat.
		° *F.*
Cotton-seed meal ¼, corn meal ¾	Peanuts alone	87.4
Cotton-seed meal ¼, corn meal ¾	Cowpea meal ⅓, corn meal ⅔, chufas, etc	82.8
Cotton-seed meal ¼, corn meal ¾	Cowpea meal ⅓, corn meal ⅔[a]	84.9

[a] Full grain ration.

By comparing the above table with that which precedes it, it will be seen that where pigs had been grazing peanuts or chufas before being fed the cotton-seed-meal ration there was a marked effect on the firmness of the fat, but where they had been on a ration of cowpea meal one-third and corn meal two-thirds there was little or no effect.

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[a] Bul. No. 122, Alabama Expt. Sta.

Another test[a] of a similar nature showed melting points of the body fat, as follows:

Effect of various feeds on the firmness of lard.

Number of pigs.[a]	Feed during 35 days before butchering.	Feed prior to 35 days before butchering.	Average melting point of body fat.
			° *F.*
2	Cotton-seed meal ⅓, corn meal ⅔	Peanuts	84.0
1	Corn meal	Peanuts	80.7
1	Corn meal (Essex pig)	Corn, grass pasture	86.0
2	Chufas	Peanuts	74.9
2	Peanuts	Peanuts	74.6

[a] Excepting the Essex pig, these were from the same litter.

These results show the softening effect of either peanuts or chufas and seem to give further evidence that a ration of cotton-seed meal and corn meal has an influence on the firmness of fat greater than that of a ration of corn alone. Duggar points out that these results do not show as firm fat as previous tests at the Alabama Station.

Another test gave still more evidence in favor of a cotton-seed meal ration, the results being as follows:[a]

Effect of cotton-seed meal on the firmness of lard.

Feed during 35 days before butchering.	Melting point of fat.	
	Kidneys.	Jowl.
	° *F.*	° *F.*
Cotton-seed meal ⅓, corn meal ⅔ (half ration); grazed sorghum	115.2	87.4
Cotton-seed meal ⅓, corn meal ⅔ (half ration); sorghum fed	115.2	85.8
Cotton-seed meal ⅓, corn meal ⅔ (half ration); grazed peanuts	99.7	80.6

The effect of cotton-seed meal, corn meal, and rice polish.—A test with these feeds following grain rations and feeding on pasture showed the following results:[a]

Effect of various feeds on the firmness of lard.

Number of pigs.	Feed during 31 days before butchering.	Feed from fifty-fifth to thirty-second day before butchering.	Average melting point of body fat.
			° *F.*
2	Cotton-seed meal ⅓, corn meal ⅔	Corn meal; peanuts	81.4
2	Corn meal	Corn meal; peanuts	78.0
1	Corn meal[b]	Grain ration	85.1
1	Corn meal; skim milk[c]	Corn meal; peanuts[d]	76.1
1	Rice polish[b]	Corn meal; peanuts[d]	74.2
1	Rice polish[b]	Grain ration	78.3

[a] Bul. No. 122. Alabama Expt. Sta.

[b] Fifty-six days.

[c] Milk for only nineteen days, and then in small amounts.

[d] Twenty-three days.

These results give still more evidence in favor of the use of a cotton-seed-meal ration to harden the fat. The body fat of the pigs fed in this manner was considerably firmer than that of those fed on corn meal.

Rice polish did not give so favorable results as corn meal.

Firmness of lard from immature pigs.—Young pigs, averaging about 60 pounds in weight at the middle of the experiment of thirty-seven days' feeding, were fed various rations and the melting point of the fat from the jowl and around the kidneys determined. The results were as follows:

Effect of immaturity on the firmness of lard.

Number of pigs.	Feed during 37 days before butchering.	Feed during preceding period of 42 days.	Average melting point of fat.	
			Kidneys.	Jowl.
			° *F.*	° *F.*
2[a]	Cotton-seed meal ¼, corn meal ¾	Grazed Spanish peanuts	86.7	67.4
2	Cowpea meal ½, corn meal ½	Grazed Spanish peanuts	80.7	72.3
2	Corn meal	Grazed Spanish peanuts	82.7	75.6
1[b]	Peanuts alone	Grazed Spanish peanuts	82.6	68.2

[a] One of the pigs in this lot died from the effects of cotton-seed-meal poisoning.

[b] This pig was butchered at the close of the forty-two days on peanuts.

These results agree with those of the Canadian experiments, that the fat of young and immature pigs is softer than that of mature ones. Duggar regards the low melting point of the fat of the pigs on cotton-seed meal in this test as due to accidental or unusual causes and therefore not of great value.

CHEMICAL COMPOSITION OF CARCASSES OF PIGS.

At the close of the Iowa experiment of 1897 one carcass from each lot, including the lots fed wide and narrow rations, was sent to Washington for analysis by the Division (now Bureau) of Chemistry[a] of the Department of Agriculture. The heads, leaf lard, and viscera were not included in the shipment, and no data are available on these parts. When the analyses were made no information was given as to the identity of the wide and narrow ration carcasses. Duroc Jersey No. 5 was from the lot fed the narrow ration, and No. 6 from those fed the wide ration.[b] In the discussion of the results these facts are considered, the tables being studied for the results with the several breeds, and then to compare the results of the two rations. The following table shows the proportions of the various parts of the carcasses:

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[a] Bul. No. 53, Div. Chemistry, U. S. D. A.

[b] Bul. No. 48, p. 408, Iowa Expt. Sta.

Relative proportions of the dressed animal, the head, leaf lard, and kidneys having been removed.

Serial number and breed of pig.	Weight (Washington).	Percentages of parts.							
		Meat (fat and lean).	Bones, less marrow.	Marrow.	Skin.	Spinal cord.	Tendons.	Hoofs.	Total.
	Pounds.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1. Berkshire	129.6	88.19	7.44	0.12	3.80	0.09	0.27	0.09	100
2. Tamworth	141.0	86.50	8.18	.21	4.71	.09	.21	.10	100
3. Chester White	125.8	87.94	6.21	.08	5.52	.07	.12	.06	100
4 Poland China	146.4	90.67	5.80	.11	3.63	.08	.14	.07	100
5. Duroc Jersey (narrow ration)	137.6	88.03	5.92	.11	5.75	.04	.10	.05	100
6. Duroc Jersey (wide ration)	167.1	90.98	4.70	.10	4.00	.07	.12	.08	100
7. Duroc Jersey	149.2	89.90	5.07	.11	4.65	.08	.11	.08	100
8. Yorkshire	160.3	86.79	7.41	.13	5.30	.09	.18	.10	100
Means	144.6	88.62	6.28	.12	4.67	.08	.16	.08	100
Maxima	167.1	90.98	8.18	.21	5.75	.09	.27	.10	100
Minima	125.8	86.50	4.70	.08	3.63	.04	.10	.05	100

Considering the carcasses that were in the breed test proper, the Yorkshire carcass is found to be very much the heaviest and the Chester White the lightest.

In relative weight of meat there is not a great amount of variation, the Poland China having the greatest weight, 90.67 per cent, and the Tamworth the least, 86.50 per cent. In relative weight of bones, less marrow, there is a range from 5.07 per cent in the Duroc Jersey to 8.18 in the Tamworth. The marrow varies from 0.08 per cent in the Chester White to 0.21 per cent in the Tamworth carcass. The skin shows a minimum of 3.63 per cent in the Poland China and a maximum of 5.52 per cent in the Chester White carcass. The weight of the spinal cord is 0.09 per cent in the Berkshire, Tamworth, and Yorkshire, and 0.07 in the Chester White. In weight of tendons, the Berkshire shows the highest percentage, 0.27, the Duroc Jersey the lowest, 0.1 per cent. In hoofs, the Tamworth and Yorkshire carcasses together were heaviest, with 0.1 per cent of the live weight, and the Chester White least, with 0.06 per cent.

It is difficult to notice any effect that may have been due to the feed which Duroc Jersey No. 5 (narrow ration) and Duroc Jersey No. 6 (wide ration) received. It will be recalled that the nutritive ratio of the narrow ration was 1:4.1, and that of the wide ration 1:7.8. There is a difference in favor of the wide-ration lot of nearly 3 per cent in weight of meat, of 1.22 per cent in weight of bones, and of 1.75 per cent in weight of skins in favor of the narrow ration. The weight of marrow is 0.11 per cent of the dressed weight in the narrow-ration carcass and 0.1 per cent in the wide ration. The weight of spinal cord is 0.04 per cent and 0.07 per cent of the narrow and wide rations, respectively, this amount for the narrow ration being the least in the table. The percentages of tendons are 0.1 and 0.12, respectively, for the narrow and wide rations, and of hoofs 0.05 per cent and 0.08 per cent, respectively. In a number of particulars the maxima or minima of the table were found for one of these carcasses, which will explain seeming inaccuracies in the preceding paragraph.

The following table shows analytical data for the carcasses examined:

Analytical data of the dressed animal, the head, leaf lard, and kidneys having been removed.

Serial number and breed of pig.	Weight.	Water.	Fat.	Nitrogenous substances.				Lecithin.	Ash.	Total.
				Proteids insoluble in hot water.	Gelatinoids.	Flesh bases.	Total.			
	Pounds.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1. Berkshire	$129\frac{3}{8}$	43.10	40.46	10.45	0.89	1.16	13.02	0.27	2.57	99.42
2. Tamworth	141	41.09	42.97	9.65	1.15	1.14′	11.99	.17	2.63	98.85
3. Chester White	$125\frac{1}{8}$	35.80	51.11	7.89	.92	1.50	9.85	.17	1.84	98.77
4. Poland China	$146\frac{3}{8}$	37.88	48.90	7.27	1.11	1.21	9.66	.19	1.83	98.41
5. Duroc Jersey (narrow ration)	$137\frac{3}{8}$	32.32	55.07	6.55	1.24	1.14	8.99	.11	2.01	98.50
6. Duroc Jersey (wide ration)	$167\frac{1}{16}$	30.31	56.81	7.73	.93	1.11	9.80	.19	1.75	98.86
7. Duroc Jersey	$149\frac{1}{8}$	30.58	57.68	7.03	1.10	.78	8.96	.42	1.81	99.45
8. Yorkshire	$160\frac{3}{16}$	40.39	44.35	8.89	1.42	1.08	11.44	.31	2.40	98.89
Means	$144\frac{1}{8}$	36.43	49.67	8.12	1.10	1.14	10.46	.23	2.11	98.90
Maxima	$167\frac{1}{16}$	43.10	57.68	10.45	1.42	1.50	13.02	.42	2.63	99.45
Minima	$125\frac{1}{8}$	30.31	40.46	6.55	.89	.78	8.96	.11	1.75	98.41

In this table the nitrogenous substances "are divided into three classes, namely, the true proteids insoluble in hot water; gelatinoids, which are of a true proteid character, but soluble in hot water, and of which gelatin is the type; and the flesh bases which are soluble in hot water and are not precipitated by the action of bromin."[a]

Lecithin was determined by extraction with a mixture of alcohol and ether and the determination of the phosphorus in the extract. As some of the lecithin is removed when the fat is extracted with ether, the determination of lecithin in the fleshy residue of the meat after fat extraction did not represent all the lecithin which was in the meat. On the other hand, in the case of marrow and spinal cord, a great proportion of these substances is fat, and for this reason and the additional one that there was a very small amount of material available for analysis, the lecithin in the fat extracted was determined as the amount in the original sample. For these reasons it is pointed out that the figures for lecithin represent less rather than more of the actual amounts in the original samples. Wiley, under whose direction the analyses were made, regards lecithin as very important physiologically.

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[a] Bul. No. 53, p. 66, Div. Chem., U. S. D. A.

In studying this table it is useless to attempt any differentiation to show the influence of the rations fed, for it is at once apparent that in the case of the narrow ration carcass (Duroc Jersey No. 5), the breed influence predominated, because, in spite of the fact that this carcass was fattened by the use of a nitrogenous ration, it will be seen that the analyses agree closely with those of the Duroc carcass in the breed test and the one on the wide ration.[a]

It is seen that the amounts of water and fat in these analyses bear an almost constant relation to each other—a minimum quantity of fat being found with a maximum quantity of water. For example, the greatest amount of water is shown in the Berkshire carcass, which also has the least amount of fat. The Duroc Jersey carcasses show a slight variation, in that carcass No. 6 (wide ration) is least in water content, with 30.31 per cent, but seventh in fat content, with 56.81 per cent. The greatest amount of fat was found in the carcass from the breed test No. 7, with 57.68 per cent. It is significant that the three Duroc Jersey carcasses are least in water content and greatest in fat content. The proportion of total nitrogen shows a tendency to vary with the amount of fat present, and does so in the case of the Berkshire, Tamworth, and Yorkshire carcasses. In proteids insoluble in hot water the Berkshire, Tamworth, and Yorkshire carcasses lead in the order named, which is the only feature of note in this column. If we consider the results for proteids insoluble in hot water, there does not seem to be any variation in gelatinoids and flesh bases that may be ascribed to breed influence; in fact, with a few exceptions, there is little variation from the mean.

The greatest percentage of lecithin (0.42) is seen in the Duroc carcass No. 7, and the least (0.11) in Duroc No. 5 (narrow ration).

The wide-ration Duroc shows .19 per cent lecithin—somewhat below the mean; the Tamworth, Berkshire, and Yorkshire, which had the greatest weight of bones, stand in the same relative order in ash content. The same tendency appears with the other carcasses, Duroc No. 7 (breed test) and Duroc No. 6 (wide ration) being seventh and eighth both in weight of bones and ash content.

Water content of fat of pigs fed various rations.—At the close of the Wisconsin experiment which compared a ration of pea meal, middlings, and skim milk with one of corn meal and skim milk, the fat of the kidney and loin of 2 pigs in each lot was analyzed to determine the water content, with the following results:

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[a] The reader should recall, however, that the narrow ration was not very different in nutritive ratio from the one used in the breed test, the one being 1:4.1; the other, 1:5.6.

Water content of fat of pigs. (*Woll.*)[a]

Feed and breed.	Kidney fat.	Loin fat.
	Per cent.	*Per cent.*
Corn meal and skim milk:		
Poland China	2.6	3.82
Yorkshire	3.15	4.55
Average	2.87	4.18
Ground pease, middlings, and skim milk:		
Poland China	8.27	7.02
Yorkshire	3.71	5.88
Average	5.99	6.45

[a] Seventeenth An. Rpt., Wisconsin Expt. Sta.

The fat from pigs on the narrow ration contained considerably less water than that from the pigs on the wide one. Carlyle and Hopkins[a] remark that they are not prepared to state what effect the larger percentage of water in the fat from the narrow-ration pigs would have "on the curing and edible qualities of the meat," but the smaller amount of water in the kidney fat of the corn-fed pigs would certainly add to its value "over the other for lard-rendering purposes."

SUCKLING PIGS ON A SKIM-MILK DIET.

Experiments with suckling pigs on a diet of separated cow's milk alone and milk to which lactose or dextrose had been added, have recently been reported by Miss Margaret B. Wilson.[b] Preliminary to the report on her work, she presents the results of similar studies by Sanford and Lusk at the Yale Medical School. In these latter experiments 1 pig was fed a ration of skim milk plus 2 per cent of milk sugar (lactose), a second a ration of skim milk plus 3 per cent dextrose, and the third skim milk only. A new-born pig from the same litter was killed and analyzed in order to determine the growth in proteid substances, the amount in the new-born pig being taken as that of the others, and the difference between the estimated amount at birth and the amount found by analysis at the close of the feeding was attributed to growth. The pigs were fed fourteen days.

Miss Wilson conducted her studies along similar lines, and throughout compared her results with those obtained by Camerer, Rubner, Oppenheimer, and others in studying the nutrition of growing infants.

Six new-born pigs from the same litter were obtained. Three of them were at once submitted to analysis, and 3 were reared on skim milk. Of these 3 the skim-milk pig was fed on skim milk alone; the lactose pig received the same skim milk to which 3 per cent of lactose had been added; and the third pig, the dextrose pig, was nourished with the same skim milk containing 3 per cent of added dextrose. After sixteen days the pigs were killed and submitted to analysis.

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[a] Seventeenth An. Rpt., p. 22, Wisconsin Expt. Sta.

[b] Amer. Jour. Physiology, VIII, 3.

The following table is presented to show some of the results relating to growth in both series of experiments:

Growth of suckling pigs.

	Wilson.			Sanford and Lusk.		
	Skim milk.	Lactose.	Dextrose.	Skim milk.	Lactose.	Dextrose.
Weight when born ....grams..	1,322.0	1,295.0	1,485.0	1,000.0	1,050.0	1,152.0
Weight when killed ....do...	2,205.0	2,435.0	2,471.0	1,246.0	1,890.0	2,000.0
Growth ....do...	883.0	1,140.0	986.0	264.0	838.0	848.0
Growth ....per cent..	66.8	88.0	66.4	26.4	79.7	73.6
Milk fed ....c.c..	10,925.0	11,005.0	9,707.0	6,826.0	8,836.0	9,481.0
Available calories fed...............	4,053.0	5,216.0	4,620.0	2,339.0	3,786.0	3,972.0
Growth per liter of milk..grams..	81.0	114.0	101.0	38.0	95.0	89.0
Growth per 1,000 calories fed .do...	218.0	215.0	213.0	114.0	222.0	213.0

Miss Wilson calls attention to the fact that, with the exception of the skim-milk pig in Sanford and Lusk's experiment, which was a poorly nourished pig that did not do well at any time, the growth of all these pigs was "directly proportioned to the calorific value of the food to the organism." She notes that Oppenheimer has obtained similar results with normal breast-fed children of the same age.

Further details relating to the growth of the pigs were ascertained. The analyses of the 3 new-born pigs were as follows:

	Grams.	Per cent.
Live weight (aggregate)............	3,247.0	....
Dry solids............	637.4	19.7
Fat............	47.56	1.15
Proteid............	390.5	12.0
CaO (average of 2 pigs)............	....	1.88

From these results data regarding the growth of the other pigs were obtained as follows:

Growth of suckling pigs. (Wilson.)

Ration.	Estimated composition at beginning.				Growth.			
	Solids.	Fat.	Proteid.	CaO.	Solids.	Fat.	Proteid.	CaO.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Skim milk..........	260.4	15.20	158.90	24.85	175.8	13.18	162.4	11.32
Lactose............	255.1	14.89	155.66	24.35	240.5	20.01	204.8	15.42
Dextrose...........	292.5	17.08	178.50	27.92	202.7	16.16	170.6	12.35

From these figures, and those relating to the feed eaten, Miss Wilson compiled the following table to show the relation between the amount of growth and consumption of feed:

Relation between feed consumed and growth.

Ration.	Feed.			Growth.			Feed used for growth.		
	Proteid.	Fat.	CaO.	Proteid.	Fat.	CaO.	Proteid.	Fat.	CaO.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*
Skim milk	455.6	15.29	21.74	162.4	13.18	11.32	35.6	86	52
Lactose	458.9	15.40	21.90	204.8	20.01	15.42	44.5	130	70
Dextrose	404.8	13.59	19.32	170.6	16.16	12.35	42.1	111	64

In Sanford and Lusk's experiments, reported by Miss Wilson,[a] the amount of proteid substances used to build up new tissue was 23 per cent for the pig on skim milk only, 38 per cent for the one on lactose, and 48 per cent for the one on dextrose. According to Miss Wilson, W. Camerer, jr.,[b] found 40 per cent proteid of the food retained for growth by a nine-weeks-old nursing infant. The results in the table show 35.6 per cent proteid retained for growth by the pig on skim milk, 44.5 per cent by the pig on lactose, and 42.1 per cent by the pig on dextrose. These results agree closely with the work quoted, especially when it is remembered that the skim-milk pig in Sanford and Lusk's experiment was not thrifty.

The relative amount of fat of growth compared to that in the food is 86 per cent with the skim-milk pig, 130 per cent with the lactose pig, and 111 per cent with the dextrose pig. This large increase is attributed to two factors—a possible error in the estimation of fat in the food and the conversion of milk sugar into fat. As the fat was "almost completely assimilated," these results show "that the carbohydrates fed were amply sufficient to furnish the needed energy, while a normal growth of tissue was progressing. No fat combustion was necesary for the life processes."

The calcium used for growth was 52 per cent of that in the food consumed by the skim-milk pig, 70 per cent of that consumed by the lactose pig, and 64 per cent of that consumed by the dextrose pig. As the dry solids of the 3 pigs contained, respectively, 8.29, 8.02, and 8.13 per cent of calcium, it is held that "the calcium addition depended rather upon the development of the organism than upon any specific influence of the milk constituents." Miss Wilson's results show an average of 9.40 per cent of calcium in the new-born pig and an average of 8.15 per cent at the age of sixteen days.

The energy stored in the animals during growth was estimated to be 772 calories in the skim-milk pig, of which 16 per cent was in the fat deposited; 1,002 calories in the lactose pig, of which 18.6 per cent was in the fat; and 832 calories in the dextrose pig, of which 18 per cent was in the fat. The following table shows facts relating to energy:

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[a] Amer. Jour. Physiology, VIII, 3, p. 200. [b] Loc. cit., p. 207.

Energy liberated in growing pigs. (*Wilson.*)

Energy—	Skimmed milk.	Lactose.	Dextose.
	Calories.	*Calories.*	*Calories.*
In the food	4,053	5,216	4,620
Stored in the body	772	1,002	832
Liberated as heat	3,281	4,214	3,788
Fed daily per square meter of surface	2,008	2,404	2,087
Liberated as heat daily per square meter of surface	1,618	2,005	1,600
Retained per 1,000 calories in the feed	191	192	180

According to Miss Wilson, "the human infant requires daily in the food about 1,200 calories per square meter of surface, while a more active older child requires 1,500." All of the pigs required over 2,000 calories per square meter of surface, and that of the lactose pig 2,400; this "corresponds to that needed by a man at hard labor." The large requirement is explained by the active, bustling life of the young pigs, which was "to a very large degree a life of hard work." Attention is called to the fact that not only did the pigs gain in weight in proportion to the number of calories in the food, but the energy stored in the body was also in proportion to the number of calories in the food.

Miss Wilson concludes that "a large and apparently normal growth" may be attained by the use of skim milk, and that the addition of sugars has a good effect, adding calorific power to the milk. She regards it as unessential whether fuel value is added to skim milk by fat, milk sugar, or dextrose, provided there is a sufficient amount of proteid in the milk; sucklings will grow well under any of these circumstances. This conclusion emphasizes the importance of the experiments by Wilson and Curtiss[a] at the Iowa Experiment Station, who found that corn meal could supply the place of fat in skim milk when fed to calves. The summary of these experiments is inserted entire as follows:

(1) Skimmed cow's milk, with or without 2 to 3 per cent of added lactose or dextrose, is normally absorbed by suckling pigs.

(2) Two pigs fed on skim milk from fourteen to sixteen days gained 26.4 and 66.8 per cent in weight. Two pigs fed on skim milk, with 2 and 3 per cent of lactose added, gained 79.7 and 88 per cent in weight. Two pigs fed on skim milk, with 2 and 3 per cent of dextrose added, gained 73.6 and 64.4 per cent in weight.

(3) Those fed with plain skim milk gained 114 and 218 grams in weight for every 1,000 physiologically available calories in the food. The lactose pigs gained 222 and 215 grams per 1,000 calories in the food. The dextrose pigs both gained 213 grams per 1,000 calories in the food. Except in the case of one ill-nourished skim-milk pig the growths of the sucklings stand in a constant ratio to the calories in the food.

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[a] Buls. Nos. 19, 25, and 35. The calves fed were considerably older than the pigs in the experiments at New Haven.

(4) The pigs fed on plain skim milk used 23 and 35 per cent of the proteid in the food for tissue growth, the lactose pigs used 38 and 44 per cent, and the dextrose pigs 48 and 42 per cent.

(5) All the pigs of the second litter gained in fat when fed on plain skim milk or on skim milk with sugars.

(6) The percentage of calcium in the bodies of the pigs diminished with their growth. There was considerable and normal deposition of calcium in the pig, and this was proportional, not to the calcium in the food, but to the growth of the animal.

(7) Not only is the growth in grams of the pigs proportional to the calories in the food, but the number of calories retained in the tissue substance during growth is proportional to the calories in the food. From 18 to 19 per cent of the calories in the food were found stored in the tissue growth of the pigs fed on the three varieties of skim milk.

(8) There seems to be striking evidence that the suckling pig reared on skim cow's milk conforms to the same laws of nutrition as the breast-fed infant.

MISCELLANEOUS EXPERIMENTS AND INFORMATION.

ACORNS.

Carver[a] has shown that acorns compare rather favorably with corn in chemical constituents. Hogs fattened on them yield rather soft, spongy flesh, with an oily lard that hardens with difficulty. This, it is suggested, might be overcome by feeding corn a few weeks before marketing. Districts in Alabama are mentioned where cattle and hogs live entirely on acorns and the pipe-stem cane.

EXPERIMENTAL PORK ON THE ENGLISH MARKET.

After each slaughtering of the Iowa pigs (see pp. 179–180) a Chicago firm shipped some of the pork to their agents at Liverpool, for sale on the English market. Very complete reports were received regarding the suitability of these cuts abroad.

In 1897 the opinion of the packers, before the above shipment was made, was that the Berkshire and Tamworth pigs were "the most suitable for the making of English meats."[b] The lots of pork that were unsuitable on account of feeding were one of long cut hams from Poland China pigs and one of long-cut hams from Chester White pigs which were "too fat and short." One lot of American-cut hams from the Berkshires was rendered unsuitable for the English market by cutting. Some of the cuts were criticised as soft and spongy, others as somewhat fat, but they were not necessarily condemned on account of fat. A tendency in the Yorkshire long-cut hams to be "rather stout" was remarked upon.

In 1898 a still more complete report was received concerning the cuts that were shipped to England. The cuts from the Tamworths were all reported suitable for the English trade, although some were criticised as being somewhat too fat. The Berkshire cuts were given second place, only two being condemned as being too fat for the British market. The showing of the Yorkshire cuts in this shipment was surprising. Out of eight Cumberlands cut from Yorkshire pigs only one was suitable for export, the others being "much too fat." Out of eight Yorkshire short-cut hams four were condemned on account of fat. The Yorkshire cuts were the least suitable of the shipment.

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[a] Bul. No. 1, Alabama, Tuskegee Inst. [b] Bul. No. 48, p. 391, Iowa Expt. Sta.

This characteristic of the Yorkshires in this experiment brings up the very important question regarding the influence of feed on the carcass. It also shows how individual and family characteristics are strong factors in experimental work. In justice to the breed it should be said that it is highly valued for its high-class pork products and is employed in every country where the production of prime bacon is a feature of pig feeding. The breed is more extensively used than any other in Denmark, where the finest bacon of international trade is produced. Yet in the Iowa tests it was said that the Yorkshires were deficient, "as the thickness of fat on the back was much greater than the trade desired."[a] The suitability of the Yorkshires for the export bacon trade is shown in the résumé on the Ontario Agricultural College work in the following paragraph:

Summarizing the results of five years of work with six breeds at Guelph, Day would rank the Yorkshire first in suitability for the export trade, placing the Tamworth second and the Berkshire third. The showing of the other breeds that were fed (Chester-White, Duroc Jersey, and Poland China) was so unsatisfactory in the production of export bacon that they could not be graded.[b] The opinion of the packer in one of the earlier tests has already been mentioned. (See pp. 207–208.) In a breed test inaugurated in collaboration with the Dominion department of agriculture the Yorkshires and Berkshires were the only breeds that made a satisfactory showing. "There were practically no culls among these breeds."[c]

THE EFFECT OF HOG RAISING ON THE FERTILITY OF THE LAND.

Following the grazing experiments, in 1898, with pigs on peanuts, chufas, and soy beans, Bennett[d] noted the effect which the grazing of the pigs and the growth of the various crops had on the soil and the cotton yield per acre. The effect was noted during the year immediately following the grazing and also for the second year. planting to ground on which corn had been grown the year before A plat of cotton was used as a check. The results, showing the amount of seed cotton produced per acre, were as follows for the first year:

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[a] Bul. No. 48, p. 429, Iowa Expt. Sta.

[b] An. Rpt., 1900, p. 48, Ontario Agricultural College.

[c] Rpt., 1901, p. 62, Ontario Agricultural College.

[d] Bul. No. 68, Arkansas Expt. Sta.

	Pounds.
Cotton following peanuts grazed by pigs	1,771
Cotton following chufas grazed by pigs	1,200
Cotton following soy beans grazed by pigs	1,588
Cotton following corn cut and stover removed	1,005

The effect of the grazing was similarly shown in the cotton yield during the second year, although the yields are said to have been decreased by unfavorable climatic conditions. The following statement shows the amount of seed cotton produced per acre the second year after grazing:

	Pounds.
Second crop cotton following peanuts	1,134
Second crop cotton following chufas	981
Second crop cotton following soy beans	1,020
Second crop cotton following corn	798

These figures show that during the first year after grazing on peanuts, soy beans, and chufas the manure left by the pigs, supplemented by the fertilizing properties of the plants themselves, increased the yield of seed cotton from nearly 20 to more than 76 per cent per acre over the yield from a plat where corn had been grown; and that during the second year the yield in favor of the grazed plats was still apparent, ranging from over 22 per cent to over 42 per cent more on the grazed than on the ungrazed plats. Naturally some of the increased yield must be attributed to the fertilizing value of the peanuts and soy beans, but as chufas are not leguminous plants and, therefore, are not equipped with nitrogen-gathering bacteria, the figures where they were used show quite accurately the manurial effect of the grazing. The increased yield on the chufa-grazed plats was nearly 20 per cent the first year after grazing and over 22 per cent the second year after.

In reporting the Tennessee experiments Soule and Fain estimated the value of the manure made by the pigs. The method of calculation used in the experiment of 1901 is not explained. In the experiments of 1902-3 the available manure was estimated at 75 per cent of the excrement voided by the animals, and its value was calculated by estimating nitrogen at 15 cents per pound, potash at 5 cents, and phosphoric acid at 5 cents. The following shows the value of the manure made during the experiment of 1901:

Value of manure in pig feeding.

Ration.	Number of pigs.	Number of days fed.	Value of manure.
Corn meal	3	60	$2.06
Corn meal and skim milk	3	60	4.12
Corn meal, wheat meal, and dairy by-products	3	60	3.80
Corn meal, cowpea hay, and skim milk	2	60	2.15

The following shows the estimated value of the manure made during the experiments of 1902–3. There were 3 pigs in each lot in the tests of 1902 and 4 in each lot in 1903. They were fed sixty days in 1902 and seventy-seven days in 1903:

Value of manure in pig feeding.

Ration.	Value of manure.
Wheat meal, corn meal, and skim milk	$3.43
Wheat meal, corn meal, and skim milk	4.34
Wheat meal, corn meal, and skim milk	5.00
Wheat meal, corn meal, and skim milk	5.23
Wheat meal, corn meal, and skim milk	4.18
Soy-bean meal, corn meal, and skim milk	4.91
Corn meal and skim milk	4.04
Corn meal	1.20

The high fertilizing value of rations composed to a considerable extent of nitrogenous feeds, such as the skim-milk rations and the soy-bean-meal ration, is apparent.

The value of the manure as a by-product of animal husbandry can not be too strongly emphasized, especially in those sections of the country, like the South, where the fertility of the land has, to a certain extent, been lost. The South supports the greater part of the business of the country in commercial fertilizers, and, while paying enormous sums annually in this manner, can not look forward to anything but greater impoverishment of the soil unless the production of live stock is increased and the manure carefully utilized.

INFLUENCE OF PROTEIN AND MINERAL MATTER ON ECONOMY OF GAIN.

The Kansas Station[a] studied the relative effects of rations, rich and poor, in protein and mineral matter in their effects on the cost of gain, with the following results:

Value of protein and mineral matter in feeding pigs.

Ration.	Protein.	Mineral matter.	Feed for 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*
Corn 66⅔ pounds, soy beans 33⅓ pounds	15.1	2.6	369
Kafir corn 66⅔ pounds, soy beans 33⅓ pounds	14.8	3.3	374
Kafir corn 80 pounds, soy beans 20 pounds	11.8	2.9	408 to 468
Corn 100 pounds	7.8	1.5	457 to 479
Kafir corn 100 pounds	7.8	2.5	471 to 749

This station calls attention to the need of mineral matter in a pig's ration, which is not supplied by Indian or Kafir corn. In experiments where pigs were confined in a stone piggery and fed either of these grains exclusively they craved mineral matter to such an extent "that they ate the mortar from between the stones."

To supply the needed protein where corn or Kafir corn forms the basis of fattening, soy beans are recommended, as they are regarded as the richest feed in protein raised on Kansas farms.

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[a] Bul. No. 95.

BONE MEAL IN A CORN-MEAL RATION.

It is generally understood that a strictly corn or corn-meal diet does not supply a sufficient amount of bone-making material (potash and phosphoric acid) to supply the wants of the animal body, and this is one reason that corn is so strongly condemned for young and growing animals. At the Cornell Station[a] Clinton fed bone meal in small amounts to pigs on corn and milk, and to others a mixture of corn meal and middlings and milk. The amount in the first trial was 1 ounce of bone meal to each 500 pounds of live weight daily; that in the second was not stated. In the first test "it did not produce any apparent results upon the health of the animals or upon the economy in the use of foods;" in the second "the bone meal seems to have produced beneficial results when fed in conjunction with the corn-meal ration, but not when fed with the grain mixture." Skim milk doubtless minimized considerably the possible effects of the bone meal.

RESULTS AT DIFFERENT PERIODS OF GROWTH.

Relative production of pork before and after weaning.—At the Al. bama Station Duggar[b] fed a sow and her litter of 7 pigs from the time of farrowing, February 24, to April 1, 1899, in a bare lot on a mixture of equal parts by weight of ground cowpeas and very coarse rice meal, consisting largely of rice chaff. The sow and pigs ate 273 pounds of the meal, the sow losing 29.6 pounds in this time and the pigs gaining 67.3 pounds, making a net gain of pork produced of 37.7 pounds, an average daily gain for the pigs during the thirty-five days of 0.15 pound.

On April 1 the sow and litter were placed in hurdles on a field of hairy vetches and turf oats, which were sown the previous October on poor upland soil. The sow was removed after five weeks, but the pigs continued for three weeks longer, making a net average daily gain of 0.13 pound.

The following table shows the results of this experiment:

Feed'ng pigs before and after weaning.

	Before weaning.	After weaning.
Number of pigs	7	7
Weight of pigs at beginning ... Pounds	118.60	232.20
Gain of pigs ... do	118.60	55.40
Loss of sow ... do	19.40	....
Net gain of sow and pigs ... do	94.20	....
Average daily gain of pigs ... do	.46	.38
Average net daily gain of sow and pigs ... do	.34	....
Meal consumed by sow and pigs ... do	554.20	[c] 244.00
Meal per pound gain of pigs ... do	488.00	440.00
Meal per 100 pounds net gain of sow and pigs ... do	588.00	....
Total weight of sow and pigs at beginning ... do	850.80	....

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[a] Bul. No. 199.

[b] Bul. No. 122.

[c] Only pigs during last three weeks.

These results show that the losses in weight of the sows, due to the drain of milking, make the production of pork while the pigs are on the dams a somewhat expensive business. Sows differ considerably in their ability to give large milk yields without consequent losses in weight. There have been cases where very good gains were made by the sow while suckling a litter (see p. 179). Duggar[a] is of the opinion that it is quite possible to maintain weight while suckling, provided the sow is given a nutritious ration. In an experiment where he fed a sow and her litter of 9 pigs on Spanish peanuts, corn meal, and skim milk the sow gained 9 pounds in weight in thirty-five days and the pigs 227 pounds, a total gain of 236 pounds. The cost of the grain and skim milk per 100 pounds gain was $2.50. Duggar regards this test as evidence "that on a sufficiently nutritious and palatable diet the weight of the nursing sow can be maintained."

Gains of pigs at various weights.—Linfield[b] averaged his results of experiments to show the gains of hogs at various weights. The table showing these averages is as follows:

Gains of pigs at various weights.

Weight.	Ration.	Number of tests.	Number of pigs.	Average daily gain.	Dry matter eaten daily.	Digestible matter eaten daily.	Feed per 100 pounds gain.		Dry matter per 100 pounds gain.	Digestible matter to 100 pounds gain.	Grain equal to 100 pounds skim milk.
							Grain.	Milk.			
				Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
From 44 to 102 pounds live weight.	Milk and grain	9	31	1.12	2.79	2.25	194	829	250	203	28.4
	Grain	6	16	.80	3.03	2.30	430	......	385	292	......
	Milk	4	11	.75	1.88	1.79	......	2,838	257	244	15.1
From 102 to 152 pounds live weight.	Milk and grain	10	34	1.42	4.93	3.93	297	879	348	277	13.6
	Grain	4	12	1.18	4.40	3.34	417	......	373	283	......
From 152 to 199 pounds live weight.	Milk and grain	8	27	1.51	5.74	4.52	357	717	381	304	28.7
	Grain	2	6	1.12	5.65	4.32	563	......	501	383	......
From 200 to 255 pounds live weight.	Milk and grain	5	19	1.39	5.79	4.51	409	590	422	329	27.8
	Grain	1	2	.97	5.83	4.44	673	......	599	457	......

These results generally corroborate the views of previous authorities on the subject of the influence of increasing age on the rate and economy of gain. A noticeable fact is that, except for the grain-fed lots, the economy of gain was greatest in the youngest pigs, decreasing as the pigs became older. With the grain-fed pigs the cheapest gains were made from 102 to 152 pounds, but after this weight the increase in cost of gain was rapid. The rate of gain is not so uniform, but the figures show pretty clearly that the greatest gains were made from 102 to 152 pounds, although those pigs on milk and grain made the largest gains from 152 to 199 pounds.

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[a] Bul. No. 122, Alabama Expt. Sta.

[b] Bul. No. 57, Utah Expt. Sta.

WATER DRUNK AT VARIOUS WEIGHTS.

From data reported by the Indiana Station[a] to study the effect of water in the feed, the writer has compiled a table showing the amount of water consumed during the experiment. The following table shows some of the leading features of this experiment:

Daily consumption of water at approximate weights.

Lot.	Ration.	Number of pigs.	Daily consumption of water by pigs weighing—								
			60 lbs.	70 lbs.	80 lbs.	90 lbs.	105 lbs.	125 lbs.	156 lbs.	180 lbs.	215 lbs.
			Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Lot I	Grain (dry)	4	2.35	3.00	2.42	4.21	4.82	7.50	11.42	9.44	11.07
Lot II	Grain and water (1:1).	4	2.42	3.27	3.35	8.27	4.50	5.60	7.50	8.39	8.17
Lot III	Grain and water (1:2).	4	4.25	6.08	6.00	6.00	7.00	9.00	11.00	14.00	14.00
Lot IV	Grain and water (1:3).	4	5.79	8.25	9.00	9.00	10.50	13.50	16.50	18.00	18.00

These figures show little difference in the consumption of water when feed was given dry and when mixed with an equal weight of water. The increase of the consumption of water with age is gradual, but not regular. The pigs that were forced to drink large quantities of water to get enough feed to satisfy hunger evidently drank more than they needed, if the figures of the dry-grain lot are a criterion.

GAIN OF PIGS FOLLOWING CATTLE.

Morrow and Bone,[b] in Oklahoma, report a case where 5 pigs following steers that were full fed on corn and Kafir meal "gained only 195 pounds, or 39 pounds each, in fifty-six days. In another case 5 pigs gained 100 pounds in fifty-six days; and in a third 6 moderate-sized sows gained 245 pounds in fifty-six days."

BARROWS COMPARED WITH SOWS.

Foster and Merrill, in Utah,[c] made two tests to compare the relative fattening values of barrows and sows. In the first test of ninety-one days, 6 barrows made an average daily gain of 0.9 pound, and 3 sows an average daily gain of 0.83 pound; in the second test of one hundred and thirty-three days, 3 barrows made an average daily gain of 0.7 pound, and 6 sows an average daily gain of 0.88 pound.

SPAYED COMPARED WITH UNSPAYED SOWS.

The same station fed 6 half-blood Berkshire sows, 3 of which were spayed and 3 were not, on a varied diet for one hundred and sixteen days.[c] The spayed sows made a daily average gain of 0.82 pound, and the unspayed sows an average daily gain of 0.86 pound. No difference of appetite was noticed.

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[a] Bul. No. 86.

[b] An. Rpt., 1898-99, Oklahoma Expt. Sta.

[c] Bul. No. 70, Utah Expt. Sta.

BUTCHERS' TERMS.

Very frequently experiment station literature on animal husbandry contains reference and tables relating to slaughter tests in packing houses. The following definitions of the terms applied to the offal and the uses of these parts have been supplied by Dr. U. G. Houck, Inspector, Bureau of Animal Industry, National Stock Yards, Ill. In this connection, the reader may find it interesting to refer to the definitions on page 186:

Melt (spleen): Uses: Tanked in offal tank.

Head, gross: Weight of head before any portion has been trimmed away.

Head, net: Head after tongue, jowls (cheeks), snout, and ears have been trimmed away.

Tongue: Uses: Boiled and pickled.

Cheek meat: Masseter muscles (*masseter externus* and *ptyerygoideus internus*). Uses: Sausage.

Cheek-meat fat: Small pieces of the fatty portion of the jowls that are unintentionally left attached to the masseter muscles when the jowls are trimmed away. Uses: Rendered into lard.

Leaf lard: A thick layer of fat extending anteroposteriorly and attached to the sublumbar and lateral abdominal parietes. Uses: Lard.

Kidneys: Uses: Human food; also one of the ingredients in the manufacture of chicken and dog feeds.

Gullet: Includes larynx, short pieces (3–6 in.) each of the trachea and esophagus and the fat attached to the parts. Uses: Fat trimmed away for lard and the remaining parts tanked in the grease tank.

Gullet fat: Fat at base of tongue that remains attached to the gullets when they are removed from the carcass. Uses: Lard.

Ham facings: Fat of the internal crural region that is removed in facing or trimming the hams. Uses: Lard.

Pluck: The term properly includes larynx, trachea, esophagus, heart, lungs, liver, a portion of the diaphragm ("skirt"), and the fat of the parts. Sometimes the lungs alone are spoken of as plucks.

Livers: In test the liver is weighed before it has been trimmed of the gall bladder and ligamentous portions. Uses: When not used in liver sausage, it is tanked in the offal tank. Sometimes used in the manufacture of prepared chicken and dog feed.

Heart: Uses: Sausage.

Lungs: In test this refers to weight of lung tissue only; the mediastinal ("heart") fat having been trimmed away for lard purposes. Uses: Offal tank.

Bladders, gross: In test includes urine contained in bladder when removed, also attached fat.

Bladders, net: Weight of bladder when empty and trimmed of fat.

Bladder fat: Some of the pelvis fat ("crotch fat") is cut away with the neck of the bladder when it is removed from the carcass. Uses: Lard.

Total weight of guts: Weight of stomach, intestinal tube, intestinal contents, and attached fat.

Gut fat: Fat of the cecum and colon, together called the "black gut;" they are emptied, washed, and tanked. Uses: Lard.

Caul and ruffle: Caul fat means the fat of the omentum. Ruffle fat is the fat of the great and colic mesenteries. Uses: Lard.

Bung guts, gross: Weight of the posterior end of the intestinal tube (rectum and 4 to 6 feet of the colon), the intestinal contents, and the attached fat.

Bung guts, net: Weight of the bung guts after they have been emptied and the fat trimmed off. Uses: The bung gut is used for sausage casings.

Bung-gut fat: The fat that is trimmed from the bung guts. This includes the "knob fat," which is a bunch of fat about the size of a man's fist that is removed from the carcass with the anus. Uses: Lard.

Small guts, gross: Weight of duodenum, jejunum, ileum, their contents and fat attached.

Small guts, net: Weight of the duodenum, jejunum, and ileum after they have been emptied, washed, and trimmed. Uses: Sausage casings.

Paunches, gross: Weight of stomach and contents.

Paunches, net: Weight of stomachs after they have been emptied and trimmed. Uses: They are filled with lard or used for the casings of head cheese. Pepsin is manufactured from some portions, and they may be rendered in the lard tank.

Pig bags (uteri): Uses: Offal tank.

Head meat: Includes the "cheek meat," "skull meat," and the "temporal," or "pate," meat.

Cheek meat: Explained above.

Skull meat: Refers to the portions of the supra-cervical muscles, principally the rectuii copitii muscles, that remain attached to the parietal ridges of the occipital bone. Uses: Sausage.

Temporal, or pate, meat: Refers to the muscles filling the temporal fossa. Uses: Sausage.

Pizzle (penis): Uses: Offal tank.

Pouch: Prepuce and the surrounding bunch of connective tissue and fat. Uses: Offal tank.

Pizzle fat: Refers to the fat of the "pouch." Uses: Offal tank.

Kidney fat (leaf lard): Uses: Lard.

Crotch fat: Refers to the intra-pelvic fat. Uses: Lard.

Weasand (esophagus): Uses: Grease tank.

Weasand meat: Muscular portion of the esophagus. Uses: Of hogs not saved, grease tank.

Stomach lining: Refers to the mucous membrane of the cardiac end of the stomach from which pepsin is made.

Chitterling (cecum): Uses: Some people cook it. Usually tanked in offal tank.

Snouts: Refers to the nose and portion of the upper lip. Uses: Pickled for food.

Sweetbreads: In hogs this refers to the pancreas only. Uses: Sometimes cooked for food. In the packing house they are usually consigned to the lard tank.

Giblets, or giblet trimmings: Refers to that portion of the pillars of the diaphragm that is cut away with the pluck when it is removed. Uses: Sausage.

Gut scrapings: Refers to the mucous membrane lining of the intestines that is scraped away in preparing casings. May include small portion of the ruffle fat that is unintentionally left on the gut. Uses: Offal tank.

Feet: Uses: Boiled and pickled for food.

Brains: Uses: Cooked for food.

Tails: Uses: Cooked for food.

Blood: Uses: As food, in the arts, in the manufacture of albumen, or for fertilizer.

STATISTICS OF PRODUCTION AND TRADE.

STATISTICS OF PRODUCTION AND TRADE.

THE CENSUS RETURNS.

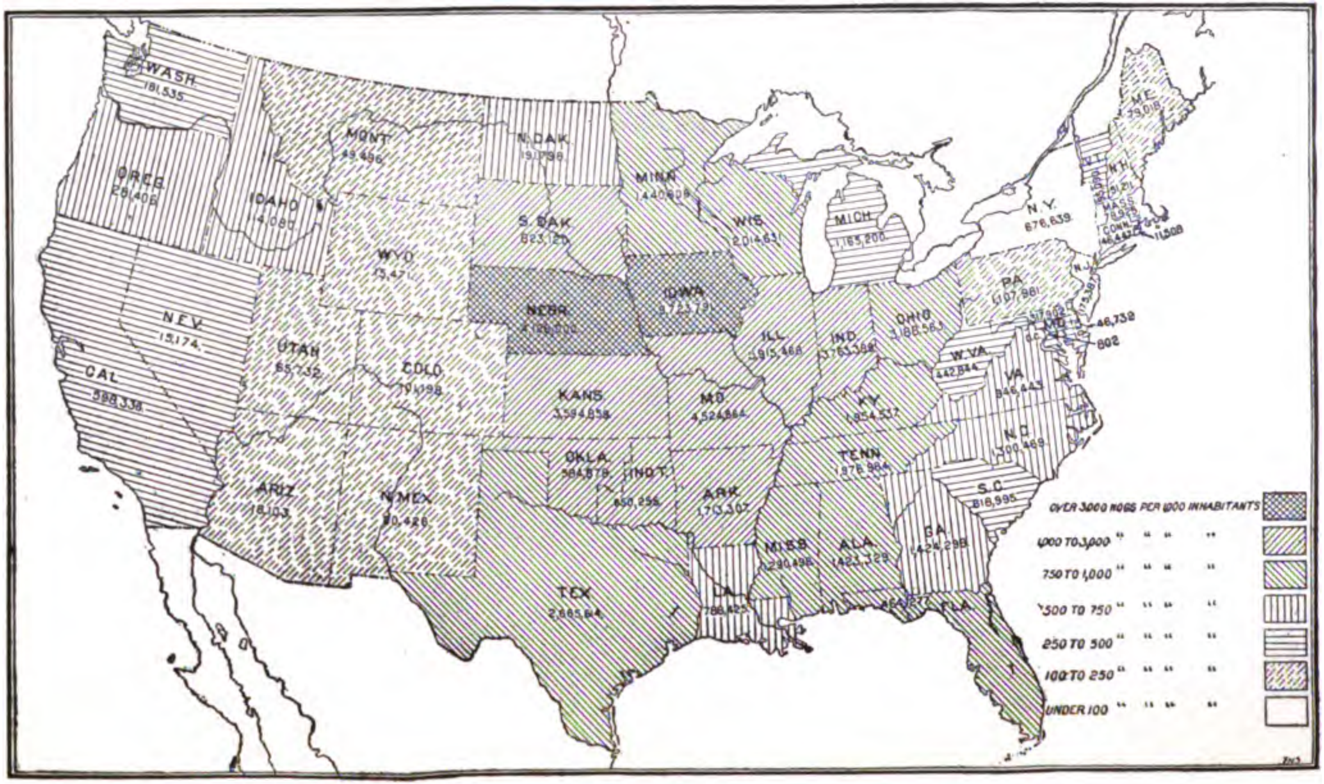
The Twelfth Census reports the total number of hogs on farms and ranges in the United States on June 1, 1900, excluding Alaska and Hawaii, as 62,868,041, with an estimated total value of $231,978,031. This is a ratio of 827 hogs per 1,000 inhabitants. "In the collection of the statistics of live stock, tabulated in the census of agriculture for 1900, three schedules were used. The first of these, known as the general farm schedule, was used by the enumerators in collecting data from the operators of farms, plantations, and ranges in all parts of the country. The second schedule was used by the special agents in recording the statistics of the larger ranches of the great West and Southwest, especially those making use of the range or public domain in sparsely settled sections of the country, where they might have been overlooked by the enumerators, or from which imperfect reports were likely to have been obtained. The third schedule was used by enumerators in collecting reports of domestic animals not on farms or ranges, especially those found in cities and villages." The foregoing figures are those of hogs on farms and ranges. This was 97.2 per cent of the total number reported. Those "in barns and inclosures elsewhere" were 1,818,114. There were 10 hogs on farms and ranges in Alaska, with an average value of $10 each, and 8,057 on farms and ranges in Hawaii, with an average value of $6.15 each.

The following table shows the returns for hogs for the United States, by States and Territories, the ratio to population, to land area and to farm area, and the average and total valuations. The farm areas used in calculating the figures in the fifth column were those reported by the Census Office, which defined a farm under the Twelfth Census as including "all the land under one management used for raising crops and pasturing live stock, with the wood lots, swamps, meadows, etc., connected therewith. It includes also the house in which the farmer resides, and all other buildings used by him in connection with his farming operations."

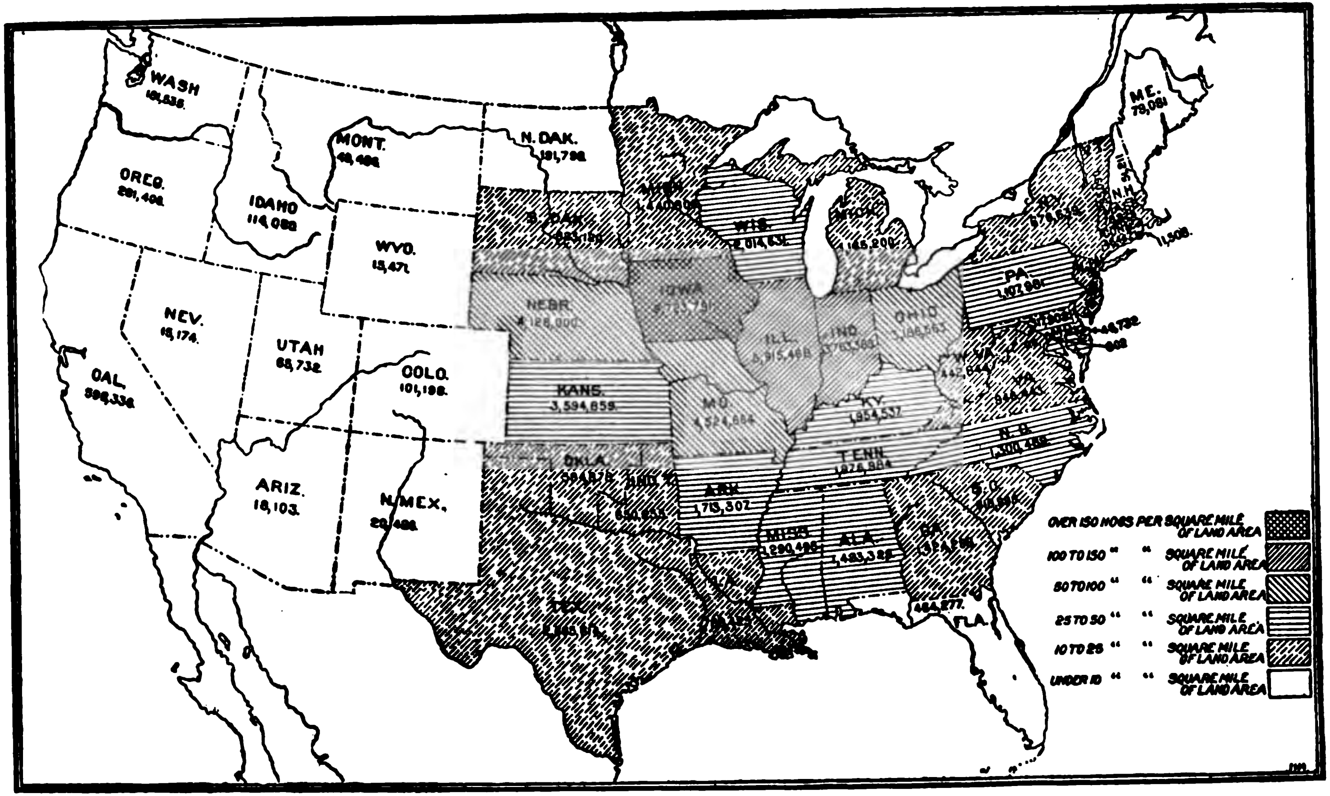
Hogs on farms and ranges in the United States in 1900.[a]

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
United States	62,868,041	827	21	48	$3.69	$231,978,031
North Atlantic division	2,322,206	110	14	23	5.60	13,011,651
Maine	79,018	114	3	8	6.53	516,015
New Hampshire	51,211	124	6	9	6.98	357,573
Vermont	95,090	277	10	13	6.52	620,169
Massachusetts	78,925	28	10	16	6.96	549,617
Rhode Island	11,508	27	11	16	7.87	90,614
Connecticut	46,447	51	10	13	7.04	326,857
New York	676,639	93	14	19	5.61	3,794,332
New Jersey	175,387	93	23	40	5.28	926,179
Pennsylvania	1,107,981	176	25	37	5.26	5,830,295
South Atlantic division	5,562,762	533	21	34	2.29	12,738,747
Delaware	46,732	253	24	28	5.02	234,472
Maryland	317,902	268	32	39	4.18	1,329,143
District of Columbia	802	3	13	60	5.11	4,097
Virginia	946,443	510	24	30	2.72	2,572,524
West Virginia	442,844	462	18	27	3.14	1,389,808
North Carolina	1,300,469	687	27	37	1.94	2,516,410
South Carolina	618,995	462	21	28	2.28	1,411,516
Georgia	1,424,298	643	24	35	1.81	2,577,950
Florida	464,277	878	9	68	1.51	702,827
North Central division	40,474,289	1,537	54	82	4.15	167,776,242
Ohio	3,188,563	767	78	83	3.70	11,818,168
Indiana	3,763,389	1,496	105	111	3.67	13,804,893
Illinois	5,915,468	1,227	106	115	3.99	23,616,781
Michigan	1,165,200	481	20	42	3.94	4,588,898
Wisconsin	2,014,631	974	37	65	3.76	7,580,423
Minnesota	1,440,806	823	18	35	4.07	5,865,590
Iowa	9,723,791	4,357	175	180	4.50	43,764,176
Missouri	4,524,664	1,456	66	85	3.65	16,533,935
North Dakota	191,798	601	3	8	4.85	930,470
South Dakota	823,120	2,050	11	28	4.30	3,540,072
Nebraska	4,128,000	3,871	54	88	4.52	18,660,932
Kansas	3,594,859	2,445	44	55	4.75	17,076,904
South Central division	13,047,827	927	21	32	2.47	32,233,204
Kentucky	1,954,537	910	49	57	2.65	5,176,183
Tennessee	1,976,984	978	47	62	2.45	4,838,713
Alabama	1,423,829	778	28	44	2.03	2,887,230
Mississippi	1,290,498	832	28	45	2.30	2,963,573
Louisiana	788,425	571	17	46	1.90	1,494,284
Texas	2,665,614	874	10	14	2.85	7,605,687
Oklahoma	584,878	1,468	15	24	4.07	2,380,025
Indian Territory	650,255	1,659	21	57	2.93	1,906,200
Arkansas	1,713,307	1,306	32	66	1.74	2,981,309

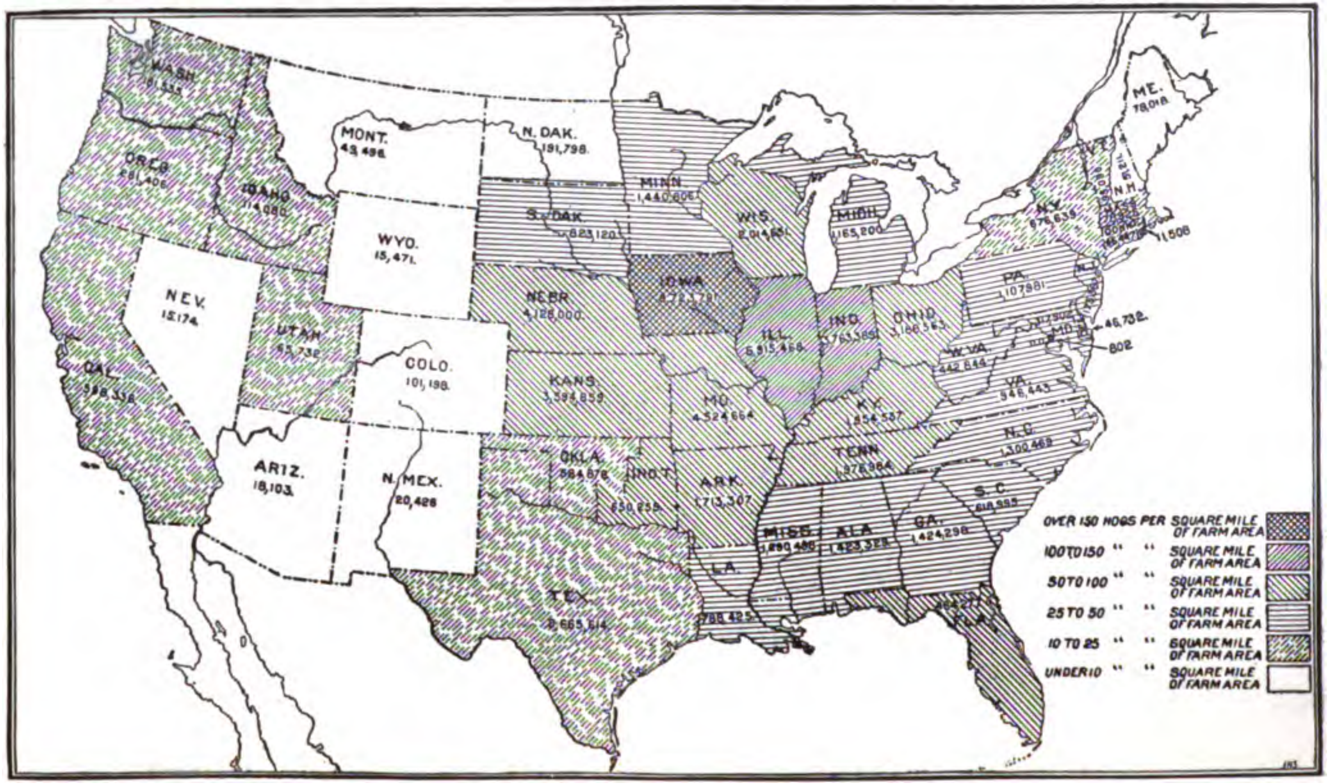
[a] Excluding Alaska and Hawaii.



NUMBER OF HOGS IN EACH STATE AND RATIO PER 1,000 POPULATION (CENSUS OF 1900).



NUMBER OF HOGS IN EACH STATE AND RATIO PER SQUARE MILE OF LAND AREA (CENSUS OF 1900).



Number of Hogs in Each State and Ratio Per Square Mile of Farm Area (Census of 1900).

Hogs on farms and ranges in the United States in 1900—Continued.

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
Western division	1,460,957	357	1	10	$4.26	$6,218,187
Montana	49,496	203	.3	3	5.69	281,402
Wyoming	15,471	167	.2	1	5.05	78,145
Colorado	101,196	188	1	7	4.77	482,722
New Mexico	20,426	105	.2	3	4.00	81,644
Arizona	18,108	147	.2	6	4.45	80,587
Utah	65,732	238	1	10	4.46	298,115
Nevada	15,174	358	.1	4	4.99	75,712
Idaho	114,080	705	1	23	4.21	480,338
Washington	181,535	350	3	14	4.58	830,704
Oregon	281,406	680	3	18	3.76	1,057,087
California	598,336	403	4	13	4.14	2,476,781

The following table shows the same facts as the preceding one, but the States are arranged so as to show particularly the overwhelming production of hogs in the corn belt. The arrangement was made with the view to grouping the States, as nearly as possible, according to (1) crops produced and climatic conditions, (2) the character of the hogs raised, and (3) proximity to market:

Hog production in the United States as related to crops, climate, and markets.

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
United States	62,868,041	827	21	48	$3.69	$231,978,031
The East and New England:						
Maine	79,018	114	3	8	6.53	516,015
New Hampshire	51,211	124	6	9	6.98	357,573
Vermont	95,090	277	10	13	6.52	620,169
Massachusetts	78,925	28	10	16	6.96	549,617
Rhode Island	11,508	27	11	16	7.87	90,614
Connecticut	46,447	51	10	13	7.04	326,857
New York	676,639	93	14	19	5.61	3,794,332
New Jersey	175,387	93	23	40	5.28	926,179
Pennsylvania	1,107,981	176	25	37	5.26	5,830,295
Delaware	46,732	253	24	28	5.02	234,472
Maryland	317,902	268	32	39	4.18	1,329,148
District of Columbia	802	3	13	60	5.11	4,097
Total	2,687,642	118	15	24	5.42	14,579,368
The South:						
Virginia	946,443	510	24	30	2.72	2,572;524
North Carolina	1,300,469	687	27	37	1.94	2,516,410
South Carolina	618,995	462	21	28	2.28	1,411,516
Georgia	1,424,298	643	24	35	1.81	2,577,950

Hog production in the United States as related to crops, etc.—Continued.

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
The South—Continued.						
Florida	464,277	878	9	68	$1.51	$702,827
Alabama	1,423,329	778	28	44	2.03	2,887,230
Mississippi	1,290,498	832	28	45	2.30	2,963,573
Louisiana	788,425	571	17	46	1.90	1,494,284
Arkansas	1,713,307	1,306	32	66	1.74	2,981,309
Tennessee	1,976,984	978	47	62	2.45	4,838,713
Kentucky	1,954,537	910	49	57	2.65	5,176,183
West Virginia	442,844	462	18	27	3.14	1,389,808
Total	14,344,406	754	27	44	2.20	31,512,327
The southwest range States:						
Indian Territory	650,255	1,659	21	57	2.93	1,906,200
Oklahoma	584,878	1,468	15	24	4.07	2,380,025
Texas	2,665,614	874	10	14	2.85	7,606,687
New Mexico	20,426	105	.2	3	4.00	81,644
Arizona	18,108	147	.2	6	4.45	80,587
Total	3,939,276	948	7	16	3.06	12,054,143
The corn belt:						
Missouri	4,524,664	1,456	66	85	3.65	16,535,985
Kansas	3,594,859	2,445	44	55	4.75	17,076,904
Nebraska	4,128,000	3,871	54	88	4.52	18,660,932
Iowa	9,723,791	4,357	175	180	4.50	43,764,176
Illinois	5,915,468	1,227	106	115	3.99	23,616,781
Indiana	3,763,389	1,496	105	111	3.67	13,804,893
Ohio	3,188,563	767	78	83	3.70	11,813,168
Total	34,838,734	1,799	84	102	4.17	145,270,789
States north of the corn belt:						
Michigan	1,165,200	481	20	42	3.94	4,588,898
Wisconsin	2,014,631	974	37	65	3.76	7,580,428
Minnesota	1,440,806	823	18	35	4.07	5,865,590
North Dakota	191,798	601	3	8	4.85	930,470
South Dakota	823,120	2,050	11	28	4.30	3,540,072
Total	5,635,555	809	17	37	3.99	22,505,453
The northwest range States:						
Montana	49,496	203	.3	3	5.69	281,402
Wyoming	15,471	167	.2	1	5.05	78,145
Colorado	101,198	188	1	7	4.77	482,722
Utah	65,732	238	1	10	4.46	293,115
Nevada	15,174	358	.1	4	4.99	75,712
Idaho	114,080	705	1	23	4.21	480,338
Total	361,151	266	.6	6	4.68	1,691,434
The Pacific coast:						
Washington	181,535	350	3	14	4.58	830,704
Oregon	281,406	680	3	18	3.76	1,057,037
California	598,396	403	4	13	4.14	2,476,781
Total	1,061,277	439	3	14	4.11	4,384,522

An examination of these tables shows that in point of numbers Iowa leads, with 9,723,791; Illinois is second, with 5,915,468. There are four States—Iowa, Illinois, Missouri, and Nebraska—with over 4,000,000 hogs, and nineteen that have over 1,000,000; seventeen States and Territories have from 100,000 to 1,000,000 hogs; fourteen have less than 100,000; and Rhode Island, the District of Columbia, New Mexico, Arizona, Wyoming, and Nevada have less than 25,000.

The proportion of hogs to population has a direct bearing on the supply of pork in relation to consumption. On this point we find that Iowa has 4,357 hogs per 1,000 inhabitants, Nebraska being next with 3,871 per 1,000 inhabitants. Eight other States have over 1,000 hogs per 1,000 inhabitants; nine have from 750 to 1,000 hogs per 1,000 inhabitants; and sixteen have more than the average for the nation, which is 827. Fifteen States and Territories have fewer than 250 hogs per 1,000 inhabitants, and six have fewer than 100.

The ratios to land and farm area bear directly on the productive capacity of the country. The third column shows this ratio for the land area regardless of the state of cultivation, including, of course, considerable uninhabitable land. Iowa leads with 175 hogs per square mile, Illinois and Indiana having 106 and 105, respectively. In addition to these States, Missouri, Nebraska, and Ohio have over 50 hogs per square mile; twenty-two States and Territories have a number equal to or exceeding 21, the average for the entire country; fifteen have less than 10 hogs per square mile.

The next column more nearly shows the actual production of hogs by the farms than the preceding one dealing with the land area. Iowa again leads, with 180 hogs per square mile, Illinois and Indiana being second and third, with 115 and 111, respectively. In addition to these States eleven have over 50 hogs per square mile of farm area. No others are above the average for the nation—48. Nine States and Territories have fewer than 10 hogs per square mile of farm area.

The State of Rhode Island reports the highest average value, $7.87; Connecticut is second, with $7.04. The Southern States report the lowest average values, which, in spite of the fact that they have large numbers, brings the total values down. For instance, New York has 676,639 hogs, with a total value of $3,794,332; while Georgia, with 1,424,298, Alabama, with 1,423,329, and Arkansas, with 1,713,307, have each over twice as many hogs as New York, but the total values are considerably less, being 21.44 per cent less in the case of Arkansas, 23.90 per cent less in the case of Alabama, and 32.05 per cent less in the case of Georgia.

In considering the groups in the second table the predominance of those States that are particularly corn-growing districts is at once apparent. This group of seven States has 34,838,734 hogs, which is 55.39 per cent of the total on farms and ranges in the United States. The ratio per 1,000 inhabitants is 1,799—twice as great as the average; the ratio per square mile of land area is 84—four times the average for the entire country; and the ratio per square mile of farm area is 102—twice the general average. In average valuation alone the corn belt fails to lead the nation.

The States that form the southwestern range follow the corn-belt States in ratio per 1,000 inhabitants, this being 948, but are low in ratio per square mile of land and farm area. The other groups follow in this order: The States north of the corn belt, with 809 per 1,000 inhabitants; the South, with 754 per 1,000 inhabitants; the Pacific coast, with 439 per 1,000 inhabitants; the northwestern range States, with 266 per 1,000 inhabitants; the East, with 118 per 1,000 inhabitants. In ratios per square mile of land area the corn belt leads with 84, the other groups following thus: The South, with 27; States north of the corn belt, with 17; the East, with 15; the Southwest, with 7; the Pacific coast, with 3; the Northwest, with 0.6. In ratio per square mile of farm area the order is as follows: The corn belt, 102; the South, 44; States north of the corn belt, 37; the East, 24; the Southwest, 16; the Pacific coast, 14; the Northwest, 6. The Eastern States lead in average valuation, with $5.42; the northwestern range States second, with $4.68; the corn belt is third, with $4.17, and the remainder as follows: The Pacific coast, with $4.11; States north of the corn belt, with $3.99; the Southwest, $3.06; the South, $2.20.

The relative positions of these groups are consolidated into the following table:

Production of hogs in United States, by regions.

Group.	Total number on farms and ranges.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.
Corn belt	First	First	First	First	Third.
South	Second	Fourth	Second	Second	Seventh.
States north of corn belt	Third	Third	Third	Third	Fifth.
Southwest	Fourth	Second	Fifth	Fifth	Sixth.
East	Fifth	Seventh	Fourth	Fourth	First.
Pacific coast	Sixth	Fifth	Sixth	Sixth	Fourth.
Northwest	Seventh	Sixth	Seventh	Seventh	Second.

TRADE STATISTICS.

THE DOMESTIC TRADE.

Before giving the following statistics it should be explained that the pork-packing year ends March 1 and is divided into two seasons—the summer season of eight months, from March 1 to November 1, and the winter season of four months, from November 1 to March 1. This system came into vogue before the days of artificial refrigeration, and, although such a designation is no longer necessary, it is still adhered to by statisticians. The figures for packing in the West (packing centers in the corn belt or States contiguous to it) are much more accurate than those for the rest of the country, where reports of operations are not so completely published.

TOTAL COST OF HOGS SLAUGHTERED.

The Cincinnati Price Current reports the total cost of hogs purchased by Western packers during the year ended March 1, 1903, as $313,537,000. The approximate cost of hogs slaughtered in the East is estimated at $67,000,000, making a total of $380,537,000, which does not include the immense number of animals killed on small farms or in towns, for which there are no commercial reports and no means of making accurate estimates. This is 2.01 per cent less than the cost for the preceding year, but over 90.11 per cent greater than the cost for the year ended March 1, 1892. The following table shows these facts in detail for the past thirteen years:

Cost of hogs slaughtered annually.

Years.	Western packing.	Eastern slaughtering.	Total.	Years.	Western packing.	Eastern slaughtering.	Total.
1902-03	$313,537,000	$67,000,000	$380,537,000	1895-96	$142,268,000	$48,000,000	$190,268,000
1901-02	323,346,000	65,000,000	388,346,000	1894-95	172,679,000	56,000,000	228,679,000
1900-01	274,680,000	58,000,000	332,680,000	1893-94	166,090,000	64,000,000	230,090,000
1899-00	212,850,000	55,000,000	267,858,000	1892-93	155,766,000	69,000,000	224,766,000
1898-99	203,696,000	50,000,000	253,696,000	1891-92	141,698,000	58,000,000	199,698,000
1897-98	174,382,000	48,000,000	222,382,000	1890-91	158,445,000	52,000,000	210,445,000
1896-97	135,456,000	42,000,000	177,456,000	1889-90	134,169,000	47,000,000	181,169,000

YEARLY COMPARISONS OF PORK PACKING.

The following table shows, by seasons and total, the number of hogs packed in the West, the total amount of green meats and lard produced, and the total cost of hogs since the year ended March 1, 1872. It will be noticed that the year ended March 1, 1902, shows the greatest number of hogs packed during any of the years given, the greatest production of green meats, except for the year 1898–99, and the greatest amount of lard except for the years 1898–99 and 1900–01. The reason for these differences is apparent when reference is made to the table showing lard averages, where it is seen that the average weight of hogs sold during the winter season of 1901–02 was the least for any year reported. The rush of light, unfinished hogs to market during the drouth of 1901 and the succeeding period of high prices for feed was the cause of this falling off in weight. Comparing with the year ended March 1, 1892, we see that during the packing year of 1901–02 there were marketed 10,954,062 more hogs than during the year 1891–92, an increase of 75 per cent; there were produced 1,098,097,000 pounds more of green meats and 324,084,000 pounds more of lard, increases of 55 per cent and 67 per cent, respectively:

Yearly comparisons of pork packing in the West.

[Cincinnati Price Current.]

Years.	Total number of hogs packed in the West.			Green meats produced.	Total lard produced.	Total cost of hogs.
	Summer season.	Winter season.	Year ended Mar. 1.			
	Number.	*Number.*	*Number.*	*Pounds.*	*Pounds.*	*Dollars.*
1872-73	505,500	5,410,314	5,915,814	955,390,000	224,810,000	64,135,000
1873-74	1,062,916	5,466,200	6,529,116	978,850,000	228,610,000	75,502,000
1874-75	1,200,444	5,566,226	6,766,670	903,847,000	231,180,000	112,943,000
1875-76	1,262,343	4,880,135	6,142,478	900,407,000	208,831,000	116,407,000
1876-77	2,307,866	5,101,308	7,409,174	1,068,450,000	243,919,000	115,965,000
1877-78	2,543,120	6,505,446	9,048,566	1,368,612,000	336,557,000	106,418,000
1878-79	3,378,044	7,480,648	10,858,792	1,579,311,000	408,702,000	94,980,000
1879-80	4,051,248	6,950,451	11,001,699	1,556,516,000	382,020,000	119,362,000
1880-81	5,323,898	6,919,456	12,243,354	1,694,253,000	409,875,000	134,944,000
1881-82	4,803,689	5,747,760	10,551,449	1,468,368,000	363,772,000	154,422,000
1882-83	3,210,787	6,132,212	9,342,999	1,315,056,000	316,063,000	154,100,000
1883-84	3,781,036	5,402,064	9,183,100	1,280,065,000	318,472,000	122,388,000
1884-85	4,058,868	6,460,240	10,519,108	1,497,357,000	364,375,000	124,754,000
1885-86	4,964,572	6,298,995	11,263,567	1,577,932,000	390,740,000	106,053,000
1886-87	5,644,003	6,439,009	12,083,012	1,619,126,000	394,118,000	119,935,000
1887-88	5,611,526	5,921,181	11,532,707	1,518,677,000	357,755,000	133,037,000
1888-89	5,315,122	5,483,852	10,798,974	1,499,251,000	359,927,000	140,903,000
1889-90	6,881,501	6,663,802	13,545,303	1,885,424,000	489,727,000	134,169,000
1890-91	9,540,008	8,173,126	17,713,134	2,371,376,000	618,732,000	158,445,000
1891-92	6,696,398	7,761,216	14,457,614	1,907,903,000	479,045,000	141,698,000
1892-93	7,757,110	4,633,520	12,390,630	1,557,111,000	388,985,000	155,766,000
1893-94	6,720,924	4,884,082	11,605,006	1,583,703,000	409,052,000	166,090,000
1894-95	8,812,125	7,191,520	16,003,645	2,072,195,000	533,055,000	172,679,000
1895-96	8,194,835	6,815,800	15,010,635	1,958,255,000	513,467,000	142,268,000
1896-97	9,979,888	6,949,090	16,928,978	2,250,158,000	662,040,000	135,456,000
1897-98	11,760,475	8,440,785	20,201,260	2,659,190,000	721,354,000	174,382,000
1898-99	13,931,550	9,720,145	23,651,695	3,030,000,000	808,473,000	203,696,000
1899-00	13,524,943	8,675,878	22,200,821	2,828,000,000	794,453,000	212,858,000
1900-01	14,322,924	9,277,750	23,600,674	2,983,000,000	805,703,000	274,682,000
1901-02	15,071,480	10,340,196	25,411,676	3,006,000,000	803,129,000	323,346,000
1902-03	12,146,965	8,458,606	20,605,571	2,579,000,000	650,707,000	313,507,000

WEIGHT, AND LARD AVERAGES.

The following table shows the average weight of hogs and the yield of lard in the West for the winter seasons ended March 1, since 1873. Note especially that, while the average weight has decreased from 290.53 pounds in 1873 to 206.38 pounds in 1902, and the yield of lard from 40.08 pounds per hog in the winter season ended March 1, 1873, to 31.30 for the winter season ended March 1, 1902, the percentage of lard yield per hog shows a slight increase.

Average live weight of hogs and yield of lard in the West for the winter seasons ended March 1.

[Cincinnati Price Current.]

Year.	Weight.	Lard.	
	Pounds.	*Pounds.*	*Per cent.*
1873	290.53	40.08	13.80
1874	268.71	35.02	13.03
1875	262.21	34.20	13.04
1876	272.13	35.45	13.03
1877	269.90	34.08	12.62
1878	282.55	38.61	13.66
1879	271.42	39.40	14.52
1880	266.17	36.32	13.65
1881	259.63	35.65	13.73
1882	262.70	36.44	13.87
1883	267.02	35.43	13.27
1884	251.44	33.25	13.22
1885	266.51	36.02	13.52
1886	258.98	35.22	13.60
1887	251.31	33.54	13.35
1888	242.30	31.06	12.82
1889	263.46	34.76	13.19
1890	250.92	36.37	14.49
1891	239.75	33.45	13.95
1892	247.64	34.69	14.01
1893	227.73	31.66	13.90
1894	248.20	36.07	14.53
1895	232.73	33.62	14.45
1896	240.71	35.53	14.76
1897	244.80	36.94	15.09
1898	235.35	34.73	14.76
1899	232.65	35.53	15.27
1900	235.67	35.97	15.26
1901	230.31	34.16	14.83
1902	206.38	31.30	15.17
1903	224.05	31.92	14.42

YEARLY COST OF HOGS.

The following table shows the average cost of hogs for the seasons and years stated. Further on a table of highest prices of hogs is given which must not be confused with this one.

Average cost of hogs packed in the West, per hundred pounds live weight, for years ended March 1.

[Cincinnati Price Current.]

Year.	Summer.	Winter.	Average for year.
1880-81	$4.20	$4.61	$4.45
1881-82	5.65	6.06	5.90
1882-83	7.20	6.28	6.65
1883-84	5.60	5.18	5.35
1884-85	5.35	4.29	4.70
1885-86	3.90	3.66	3.75
1886-87	4.10	4.19	4.15
1887-88	4.75	5.04	4.90
1888-89	5.58	4.99	5.26
1889-90	4.30	3.66	3.98
1890-91	3.91	3.54	3.74
1891-92	4.48	3.91	4.16
1892-93	$5.03	$6.54	$5.60
1893-94	6.33	5.26	5.87
1894-95	4.98	4.28	4.67
1895-96	4.41	3.68	4.07
1896-97	3.30	3.30	3.30
1897-98	3.70	3.53	3.63
1898-99	3.85	3.52	3.71
1899-00	4.00	4.20	4.11
1900-01	5.12	5.02	5.07
1901-02	5.92	5.97	5.94
1902-03	7.06	6.44	6.81

WINTER PACKING IN THE WEST.

The following table shows the total number of hogs packed in the West during the winter seasons, and cost of hogs per 100 pounds live weight since 1842. Before 1873, these figures represent practically the total number of hogs packed in the West for the years given. Summer packing began in September of that year, when it is said to have reached the number of 505,500.

Number of hogs packed in the West during the winter seasons, and cost of hogs per 100 pounds live weight.

[Cincinnati Price Current.]

Season.	Number.	Cost.	Season.	Number.	Cost.
1902-03	8,458,606	$6.44	1871-72	4,831,558	$4.12
1901-02	10,340,196	5.97	1870-71	3,695,251	5.26
1900-01	9,277,750	5.02	1869-70	2,635,312	9.22
1899-00	8,675,898	4.29	1868-69	2,499,873	8.18
1898-99	9,720,145	3.52	1867-68	2,781,084	6.36
1897-98	8,440,785	3.53	1866-67	2,490,791	5.78
1896-97	6,949,090	3.30	1865-66	1,785,955	9.34
1895-96	6,815,800	3.68	1864-65	2,422,779	11.46
1894-95	7,191,520	4.28	1863-64	3,261,105	5.36
1893-94	4,884,082	5.26	1862-63	4,069,520	3.36
1892-93	4,633,520	6.64	1861-62	2,893,666	2.42
1891-92	7,761,216	3.91	1860-61	2,155,702	4.57
1890-91	8,173,126	3.54	1859-60	2,350,822	4.73
1889-90	6,663,802	3.66	1858-59	2,465,552	5.02
1888-89	5,483,852	4.99	1857-58	2,210,778	3.89
1887-88	5,921,181	5.04	1856-57	1,818,468	4.75
1886-87	6,439,009	4.19	1855-56	2,489,502	4.60
1885-86	6,298,995	3.66	1854-55	2,124,404	3.37
1884-85	6,460,240	4.29	1853-54	2,534,770	3.85
1883-84	5,402,064	5.18	1852-53	2,201,110	4.81
1882-83	6,132,212	6.28	1851-52	1,182,846	3.56
1881-82	5,747,760	6.06	1850-51	1,332,867	3.00
1880-81	6,919,456	4.64	1849-50	1,652,220	2.13
1879-80	6,950,451	4.18	1848-49	1,560,000	3.75
1878-79	7,480,648	2.85	1847-48	1,710,000	2.60
1877-78	6,505,446	3.99	1846-47	825,000	2.85
1876-77	5,101,308	5.74	1845-46	940,000	3.90
1875-76	4,880,135	7.05	1844-45	790,000	2.65
1874-75	5,566,226	6.66	1843-44	1,245,000	
1873-74	5,466,200	4.34	1842-43	675,000	
1872-73	5,410,314	3.73			

TOTAL PACKING IN THE EAST.

The next table gives the statistics for Eastern packing, but these figures do not include the consumption of hogs at New York, Baltimore, and Philadelphia. Returns of hogs packed at these cities are not available, and the number of hogs consumed is approximated by taking the receipts at these places. This gives a fair estimate, as comparatively few hogs are shipped out. It is seen at once that, while there was an almost constant yearly increase in the number of hogs packed in the East from 1882 to 1892, during the last decade (1892–1902) this number has been nearly constant or has shown a slight tendency to decrease. The receipts at the three cities of New York, Baltimore, and Philadelphia, shown in a later table, have a similar tendency. If there has been the same relative decrease in average weight in the East that has been noted as a feature of the Western situation, which is not unreasonable to suppose, we may infer that pork production has decreased slightly in the East during the last ten years. The table embraces Boston, New Haven, Providence, Worcester, Brightwood, Fall River, Bridgeport, etc., in New England; Buffalo, Albany, Troy, Hudson, etc., in New York; and Pottsville, Harrisburg, Mount Carmel, Allentown, Chester, Coatesville, etc., in Pennsylvania.

Aggregate number of hogs packed in the East during the year ended March 1, for summer and winter seasons and for the year.

[Cincinnati Price Current.]

Year.	Summer.	Winter.	Twelve months.	Year.	Summer.	Winter.	Twelve months.
	Number.	*Number.*	*Number.*		*Number.*	*Number.*	*Number.*
1902-03	1,702,000	1,093,000	2,795,000	1891-92	1,658,409	1,113,754	772,163
1901-02	1,728,000	1,021,000	2,749,000	1890-91	1,473,961	1,066,200	2,540,161
1900-01	1,683,000	1,077,000	2,760,000	1889-90	1,378,520	959,813	2,338,333
1899-00	1,996,000	1,096,000	3,092,000	1888-89	1,231,069	859,434	2,090,563
1898-99	1,895,000	1,269,000	3,164,000	1887-88	1,306,849	951,708	2,258,557
1897-98	1,883,600	1,188,500	3,072,100	1886-87	1,113,410	807,115	1,920,525
1896-97	1,659,800	1,131,100	2,790,900	1885-86	991,448	687,810	1,679,258
1895-96	1,546,500	1,056,000	2,602,500	1884-85	935,238	614,516	1,549,754
1894-95	1,863,000	1,235,500	3,098,500	1883-84	848,153	628,294	1,476,447
1893-94	1,638,205	1,063,029	2,701,234	1882-83	824,031	509,071	1,333,102
1892-93	1,989,720	1,026,310	3,016,030				

VISIBLE MARKETING OF HOGS.

The following compilation shows the comparative visible marketing of hogs for years ended March 1, as indicated by Western and Eastern packing returns and receipts at New York, Philadelphia, and Baltimore:

Visible marketing of hogs, 1879–1903.

[Cincinnati Price Current.]

Year.	Western packing.	Eastern packing.	Receipts at 3 cities.	Total.
	Number.	*Number.*	*Number.*	*Number.*
1879-80	11,002,000	1,154,000	2,673,000	14,829,000
1880-81	12,243,000	1,209,000	2,701,000	16,153,000
1881-82	10,551,000	1,005,000	2,915,000	14,471,000
1882-83	9,343,000	1,333,000	2,450,000	13,126,000
1883-84	9,183,000	1,476,000	2,594,000	13,253,000
1884-85	10,519,000	1,550,000	2,658,000	14,727,000
1885-86	11,264,000	1,679,000	2,883,000	15,826,000
1886-87	12,083,000	1,995,000	2,905,000	16,983,000
1887-88	11,533,000	2,258,000	2,599,000	16,390,000
1888-89	10,799,000	2,091,000	2,760,000	15,650,000
1889-90	13,545,000	2,338,000	3,023,000	18,906,000

Visible marketing of hogs, 1879-1903—Continued.

Year.	Western packing.	Eastern packing.	Receipts at 3 cities.	Total.
	Number.	*Number.*	*Number.*	*Number.*
1890-91	17,713,000	2,540,000	3,713,000	23,966,000
1891-92	14,457,000	2,771,000	3,684,000	20,912,000
1892-93	12,390,000	3,016,000	2,790,000	18,196,000
1893-94	11,605,000	2,701,000	2,483,000	16,789,000
1894-95	16,003,000	3,099,000	2,517,000	21,619,000
1895-96	15,010,000	2,603,000	2,867,000	20,480,000
1896-97	16,929,000	2,791,000	2,950,000	22,670,000
1897-98	20,201,000	3,072,000	2,861,000	23,134,000
1898-99	23,651,000	3,164,000	2,978,000	29,793,000
1899-00	22,201,000	3,092,000	2,879,000	28,172,000
1900-01	23,600,000	2,760,000	2,620,000	28,980,000
1901-02	25,411,000	2,749,000	2,235,000	30,395,000
1902-03	20,605,000	2,795,000	1,840,000	25,245,000

Commenting on these figures, the Price Current calls attention to the fact that it is difficult to estimate satisfactorily the number of hogs slaughtered in the country—on farms, etc.—which are not included in the above figures, but it is likely this number has been 10,000,000 or more each year in late years, bringing the aggregate slaughtering up to approximately 40,000,000 for the entire country in years of larger operations, in periods of most plentiful supplies.

LARD PRODUCTION COMPARISONS.

The total lard production of western packing for years ended March 1, and also for the packing at eastern cities, and from hogs slaughtered at New York, Baltimore, and Philadelphia, are shown in the following:

Production of lard, 1880-1903.

[Cincinnati Price Current.]

Year.	Western packing.	Other production.	Total.	Year.	Western packing.	Other production.	Total.
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
1880-81	409,875,000	107,785,000	517,660,000	1892-93	388,985,000	145,000,000	533,985,000
1881-82	363,772,000	105,157,000	468,929,000	1893-94	409,052,000	130,000,000	539,052,000
1882-83	316,063,000	103,450,000	419,513,000	1894-95	533,055,000	140,000,000	673,055,000
1883-84	318,472,000	125,978,000	444,450,000	1895-96	513,467,000	136,000,000	649,467,000
1884-85	364,376,000	116,029,000	480,405,000	1896-97	662,040,000	143,500,000	805,540,000
1885-86	390,741,000	123,489,000	514,230,000	1897-98	721,354,000	148,000,000	869,354,000
1886-87	394,118,000	132,914,000	527,032,000	1898-99	808,473,000	153,000,000	961,473,000
1887-88	357,755,000	129,424,000	487,179,000	1899-00	794,453,000	150,000,000	944,453,000
1888-89	359,927,000	123,975,000	483,902,000	1900-01	805,703,000	135,000,000	940,703,000
1889-90	489,727,000	134,500,000	624,227,000	1901-02	803,129,000	125,000,000	928,129,000
1890-91	618,732,000	156,300,000	775,032,000	1902-03	650,707,000	115,000,000	765,707,000
1891-92	479,000,000	163,000,000	642,000,000				

THE FOREIGN TRADE.

EXPORTS OF HOGS AND HOG PRODUCTS.

The following figures show the export trade in hogs and hog products, by countries, for the past three fiscal years ended June 30. The most striking feature of our foreign trade is the almost complete predominance of exports. This is so great that, except for bristles, the imports have not received separate enumeration by the Treasury Department. The balance of trade in bristles is still in favor of foreign countries:

Exports of hogs and hog products during three years, 1901–1903.

[Bureau of Statistics, Treasury Department.]

Article and country of import.	1901.		1902.		1903.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
Hogs exported to—	*Number.*	*Dollars.*	*Number.*	*Dollars.*	*Number.*	*Dollars.*
British North America	1,427	12,886	2,352	17,535	1,318	11,608
Mexico	2,904	32,709	2,002	25,939	1,191	11,470
West Indies and Bermuda	17,920	191,772	3,951	43,779	1,223	15,295
South America	14	255	33	885		
Asia and Oceania	6	250			17	366
Other countries	47	593	30	192	282	2,184
Total	22,318	238,465	8,368	88,330	4,031	40,923
	Gallons.		*Gallons.*		*Gallons.*	
Lard oil	766,783	438,645	460,035	327,794	356,658	306,334
Bacon exported to—	*Pounds.*		*Pounds.*		*Pounds.*	
United Kingdom	369,082,490	30,884,512	310,380,793	28,927,610	162,549,709	17,572,088
Belgium[a]			21,361,704	1,941,997	11,349,214	1,131,406
France	2,755,224	196,782	845,484	75,048	447,546	44,796
Germany	18,394,390	1,386,055	20,009,656	1,675,155	13,705,305	1,339,119
Netherlands [a]			5,736,628	499,230	3,764,141	385,211
Other Europe	51,340,500	3,758,615	38,208,232	3,393,449	4,761,205	479,095
British North America	4,524,858	435,964	5,778,081	621,958	4,179,619	474,302
Central American States and British Honduras	323,465	29,608	319,766	29,888	250,919	26,795
Mexico	303,728	32,733	291,747	32,890	241,699	32,775
Santo Domingo	21,049	1,944	13,062	1,302		
Cuba	5,687,418	456,456	4,111,136	364,536	3,346,240	345,233
Porto Rico [b]						
Other West Indies and Bermuda	380,530	39,086	367,206	41,747	357,117	49,033
Brazil	2,456,927	191,186	1,908,467	181,708	1,774,305	213,199
Colombia	19,331	1,776	23,271	2,204	28,066	3,181
Other South America	311,350	27,357	319,153	33,368	154,991	17,773
Chinese Empire	170,487	23,400	118,158	17,976	95,157	16,233
Hawaii [b]						

[a] Included in "Other Europe" prior to 1902.

[b] The commerce between the United States and Hawaii and Porto Rico, respectively, is not included in the statements of the foreign trade of the United States after June 30, 1900, but after this date the trade of Hawaii, and after July 1, 1901, of Porto Rico, with foreign countries is included in the statement of the domestic commerce of the United States.

Exports of hogs and hog products during three years, 1901–1903—Continued.

Article and country of import.	1901.		1902.		1903.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
Bcaon exported to—Con.	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
Philippine Islands	1,015	152	79,022	9,922	37,918	6,207
Other Asia and Oceania	117,552	15,662	109,575	16,708	182,082	20,508
Africa	223,432	17,738	267,865	24,328	110,767	11,571
Total	456,122,741	37,499,026	383,150,624	35,449,797	207,336,000	22,178,525
Hams exported to—						
United Kingdom	191,127,894	20,269,042	202,390,263	22,569,633	189,026,769	22,797,301
Belgium[a]	------------	------------	6,648,096	674,814	3,814,913	411,308
France	667,119	65,310	180,041	18,572	135,740	14,843
Germany	2,156,646	218,758	2,128,576	219,826	1,143,210	116,658
Netherlands[a]	------------	------------	2,271,815	233,515	1,506,088	158,022
Other Europe	8,990,378	883,689	9,820,647	1,003,123	2,128,325	243,501
British North America	2,770,198	302,793	3,480,795	375,436	7,720,075	896,608
Central American States and British Honduras	324,484	34,603	273,098	31,088	228,239	29,491
Mexico	422,185	49,628	476,172	58,690	488,523	64,699
Santo Domingo	108,412	13,397	88,513	11,809	------------	------------
Cuba	6,261,019	595,776	5,576,814	554,590	4,719,571	542,695
Porto Rico[b]	------------	------------	------------	------------	------------	------------
Other West Indies and Bermuda	1,923,525	190,428	1,672,575	184,677	1,565,887	205,782
Brazil	50,518	5,921	29,171	3,209	17,854	2,286
Colombia	179,669	18,023	152,210	16,164	116,630	14,551
Other South America	682,310	83,510	599,733	77,154	626,771	82,847
Chinese Empire	260,556	34,671	166,615	24,137	220,297	34,925
British Australasia	83,684	8,173	2,787	272	33,934	4,207
Hawaii[b]	------------	------------	------------	------------	------------	------------
Philippine Islands	68,212	8,756	201,264	24,475	100,562	13,495
Other Asia and Oceania	275,011	36,791	212,216	28,464	251,814	37,206
Africa	197,280	20,798	181,433	18,956	314,943	39,637
Other countries	27,713	2,711	20,309	2,409	23,220	3,061
Total	216,571,808	22,842,778	227,653,232	25,222,744	214,183,365	25,712,683
Pork:						
Canned	8,945,594	708,381	9,608,882	832,910	13,590,897	1,369,687
Fresh	30,728,586	2,424,537	44,171,674	3,652,464	20,966,113	2,035,491
Salted or pickled	138,643,611	9,926,633	115,896,275	10,117,562	95,287,374	9,959,762
Total fresh and salted	169,372,197	12,351,170	160,067,949	13,770,026	116,253,487	11,995,253
Exported to—						
United Kingdom	88,731,438	6,830,647	98,504,537	8,641,863	71,497,640	7,592,301
Belgium[a]	------------	------------	6,047,148	520,219	3,915,839	402,417
France	111,925	7,196	78,000	6,750	89,300	8,851
Germany	9,830,423	655,697	8,671,775	719,438	2,896,130	270,437
Netherlands[a]	------------	------------	8,277,773	714,704	2,767,981	284,633
Other Europe	30,451,098	2,096,818	21,834,445	1,860,467	6,651,407	667,249
British North America	10,241,105	668,047	9,935,122	754,852	9,698,420	917,802

[a] Included in "Other Europe" prior to 1902.

[b] See note *b*, page 259.

Exports of hogs and hog products during three years, 1901-1903—Continued.

Article and country of import.	1901.		1902.		1903.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
Pork—Continued.	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
Exported to—						
Central American States and British Honduras	1,532,495	107,511	1,319,601	107,536	1,407,465	131,543
Santo Domingo	135,490	10,042	110,842	9,594	....	....
Cuba	7,902,577	587,849	5,734,050	491,486	2,902,606	270,016
Porto Rico[a]	....	....	....	....	....	....
Other West Indies and Bermuda	15,684,141	1,047,020	10,069,824	853,084	8,151,649	806,051
Brazil	3,800	262	19,600	1,900	188,050	19,255
Colombia	229,332	17,292	194,762	16,588	129,060	12,896
Other South America	4,006,308	281,899	3,278,446	278,115	3,097,524	301,266
Philippine Islands	....	....	9,800	950	17,913	2,045
Other Asia and Oceania	96,635	7,768	76,085	6,600	1,223,622	122,785
Africa	166,300	11,675	119,800	10,365	1,528,055	176,737
Other countries	299,130	21,447	111,310	10,438	90,826	9,479
Total	169,372,197	12,351,170	160,067,949	13,770,026	116,258,487	11,995,253
Lard exported to—						
United Kingdom	211,264,628	16,377,255	199,442,907	19,019,841	196,458,773	20,747,232
Belgium[b]	....	....	30,404,860	2,874,757	23,702,251	2,413,561
France	15,471,922	1,148,518	7,801,007	691,961	4,346,321	427,708
Germany	182,389,879	13,700,875	173,269,658	16,237,434	148,962,391	15,448,596
Italy[a]	....	....	2,348,733	222,845	3,375,019	351,265
Netherlands[a]	....	....	53,269,049	5,060,486	42,002,215	4,470,418
Other Europe	112,222,710	8,434,928	108,040,377	10,147,575	18,925,850	1,900,150
British North America	3,321,798	270,609	1,737,936	175,156	1,889,844	141,840
Central American States and British Honduras	2,551,001	203,598	1,756,920	170,670	1,487,472	144,779
Mexico	6,987,766	454,040	8,098,615	702,082	3,448,455	320,691
Santo Domingo	506,279	40,571	471,934	46,355	....	....
Cuba	38,304,327	2,811,696	25,374,052	2,144,229	20,379,728	1,812,639
Porto Rico[b]	....	....	....	....	....	....
Other West Indies and Bermuda	6,749,150	529,887	5,904,362	543,697	7,281,986	676,513
Argentina	107,893	9,218	68,195	7,028	40,471	4,414
Brazil	12,938,329	1,124,619	10,194,268	1,059,556	6,018,988	688,236
Chile[c]	....	....	413,285	45,868	546,222	60,197
Colombia	1,480,890	115,264	1,145,374	98,995	1,910,567	176,260
Venezuela[c]	....	....	4,014,964	418,767	2,467,068	243,675
Other South America	12,708,416	1,001,679	9,058,826	890,548	4,056,847	385,777
Hawaii[b]	....	....	....	....	....	....
Philippine Islands	77,255	6,975	211,821	19,700	135,471	14,761
Other Asia and Oceania	2,108,855	148,827	744,073	67,541	1,094,727	114,506
Africa	2,155,971	176,812	3,465,662	348,519	2,696,205	308,080
Other countries	70,445	4,777	54,235	4,957	29,430	3,204
Total	611,357,514	46,560,148	556,840,222	52,375,864	490,755,821	50,854,504

[a] Included in "Other Europe" prior to 1902.

[b] Omitted as part of foreign traffic of United States after June 30, 1900.

[c] Included in "Other South America" prior to 1902.

The export trade in live hogs is not an important factor of the industry, and the tendency on the part of dealers to ignore it is evident, especially when these figures are compared with those in the next table, which show exports since 1790. The greater proportion of live hogs exported go to the West Indies and Bermuda, Mexico, and British America.

The quantities of lard oil exported during the fiscal year ended June 30, 1903, were considerably less than those of 1902, and decidedly so as compared with 1901.

In exports of hog products bacon first commands our attention. It is noteworthy that there has been a very large decrease in the quantities exported during the last three years, but there is not the same decrease in total values; indeed, the latter have remained practically stationary. This is due, of course, to the rapid rise in domestic prices, which has also had much to do with the falling off in the foreign demand.

In all kinds of meat products of hogs the United Kingdom is our best customer. In bacon Germany stands second, but during the period under consideration Great Britain and Ireland purchased from twelve to twenty times as much bacon as Germany. Since being separately reported, Belgium shows purchases of bacon fully as large as those of Germany.

Hams show an increase from 196,414,412 pounds in 1900, valued at $20,416,367, to 227,653,232 pounds in 1902, valued at $25,222,744, but a decrease to 214,183,365 pounds in 1903, valued at $25,712,633. The purchases of United States hams by the United Kingdom form about 85 per cent of our total export trade in this product.

Pork exports have also decreased during the past three years. While the United Kingdom purchases a greater percentage of our hams and bacon than she does of our fresh pork, she takes more than half our exports of this product—continental Europe, the West Indies and Bermuda, and British America figuring rather prominently among the other purchasers.

Lard has also fallen in foreign demand. The United States sells the United Kingdom practically all the lard she imports, other countries also purchasing immense quantities. The United Kingdom takes about one-third the total amount, Germany following closely, and very large amounts go to other European countries.

The following table shows the total exports of hogs and hog products since and including the year 1790:

Total exports of hogs, hams and bacon, pork, and lard from the United States.[a]

Fiscal year.[b]	Live hogs.		Hams and bacon.		Pork.		Lard.	
	Number.	Value.	Pounds.	Value.	Barrels.	Value.	Pounds.	Value.
		Dollars.		*Dollars.*		*Dollars.*		*Dollars.*
1790	5,304	14,481	253,555	19,728	24,462	208,099	355,880	31,475
1791	16,803	45,368	295,647	26,590	[c]26,635	266,350	522,715	41,817
1792	21,291	....	585,353	....	[d]38,098	....	515,245	....
1793	9,901	....	521,483	....	38,563	....	596,397	....
1794	5,705	....	1,147,262	....	49,453	....	1,100,780	....
1795	4,922	....	1,778,564	....	88,193	....	1,490,554	....
1796	6,753	....	2,096,877	....	73,881	....	1,124,971	....
1797	3,484	....	1,084,008	....	40,125	....	731,511	....
1798	4,237	....	1,105,584	....	33,115	....	876,773	....
1799	3,786	....	1,412,005	....	52,268	....	1,451,657	....
1800	14,294	....	1,178,244	....	55,467	....	1,633,562	....
1801	7,812	....	2,034,630	....	70,779	....	2,376,500	....
1802	5,501	....	1,588,267	....	78,239	....	1,958,400	....
1803	6,859	....	1,686,546	....	96,602	....	2,052,302	....
1804	5,599	....	1,904,284	....	111,532	....	2,565,719	....
1805	2,808	....	903,924	....	57,925	....	1,308,287	....
1806	1,747	....	1,347,018	....	36,277	....	1,542,500	....
1807	1,831	....	1,311,246	....	39,274	....	1,815,998	....
1808	1,956	....	258,418	....	15,478	....	585,173	....
1809	537	....	1,082,610	....	42,652	....	1,871,089	....
1810	250	....	1,218,855	....	37,209	....	1,365,833	....
1811	4,454	....	1,286,809	....	37,270	....	1,927,451	....
1812	2,380	....	729,398	....	22,746	....	1,616,417	....
1813	485	....	607,196	....	17,337	....	1,084,565	....
1814	160	....	138,556	....	4,040	....	513,928	....
1815	757	....	695,357	....	9,073	....	1,045,633	....
1816	1,988	....	530,129	....	19,280	....	1,068,348	....
1817	1,103	5,515	341,419	61,455	14,462	303,702	926,018	166,688
1818	524	2,882	602,274	102,387	17,553	403,719	1,363,663	245,459
1819	2,824	13,944	700,369	105,055	28,173	563,460	2,178,076	326,711
1820	3,627	38,270	1,005,462	120,655	44,091	705,456	2,636,636	316,396
1821	7,885	....	1,607,506	....	66,647	....	3,996,561	....
1822	9,798	....	1,142,945	....	68,352	....	4,137,814	....
1823	11,436	....	1,637,157	....	55,529	....	6,067,071	....
1824	8,838	....	1,409,199	....	67,229	....	5,053,182	....
1825	4,525	....	1,896,359	....	85,709	....	5,483,048	....
1826	6,939	....	1,836,133	....	88,994	....	7,231,643	....
1827	18,441	....	1,864,956	....	73,813	....	6,927,084	....
1828	16,171	....	1,837,920	....	53,836	....	7,493,319	....
1829	10,779	....	2,305,405	....	59,539	....	7,154,742	....
1830	22,294	....	2,154,986	....	45,645	....	6,001,417	....
1831	14,690	....	1,477,446	....	51,263	....	6,963,516	....
1832	5,266	....	1,810,830	....	88,625	....	7,756,782	....
1833	6,819	....	1,786,637	....	105,870	....	7,655,198	....
1834	3,338	....	1,530,638	....	82,691	....	9,050,342	....
1835	3,930	....	1,492,027	....	61,827	....	10,637,490	....
1836	1,231	....	1,398,475	....	22,550	....	6,493,878	....

[a] Domestic and foreign exports were not separated until 1803; from this date the figures are for domestic exports only.

[b] The fiscal year ended September 30 up to and including 1842; thereafter June 30.

[c] Not including 29,334 pounds "fresh pork," valued at $1,760.

[d] Not including 3,008 pounds "fresh pork."

Total exports of hogs, hams and bacon, pork, and lard, etc.—Continued.

Fiscal year.	Live hogs.		Hams and bacon.		Pork.		Lard.	
	Number.	Value.	Pounds.	Value.	Barrels.	Value.	Pounds.	Value.
		Dollars.		*Dollars.*		*Dollars.*		*Dollars.*
1837....	1,110	....	965,935	....	24,583	....	6,388,174	....
1838....	366	....	1,194,890	....	31,356	....	7,209,478	....
1839....	772	....	1,445,527	....	41,301	....	7,723,834	....
1840....	4,854	....	1,643,397	....	66,281	....	7,418,847	....
1841....	7,901	....	2,794,517	....	133,290	....	10,597,654	....
1842....	5,564	....	2,518,841	....	180,032	....	20,102,397	....
1843[a] ..	7,162	....	2,422,067	....	80,310	....	24,534,217	....
1844....	9,615	....	3,886,976	....	161,629	....	25,746,355	....
1845....	6,384	....	2,719,960	....	161,609	....	20,060,993	....
1846....	7,437	....	3,006,630	....	190,422	....	21,843,164	....
1847....	3,274	(b)	17,921,471	....	206,190	....	37,611,161	....
1848....	4,750	(b)	33,551,074	....	218,259	....	49,625,530	....
1849....	1,121	(b)	56,060,822	....	253,483	....	37,446,761	....
1850....	881	(b)	41,014,528	....	188,841	....	54,925,546	....
1851....	1,030	(b)	18,027,302	....	165,201	....	19,683,082	....
1852....	185	(b)	5,746,016	....	83,382	....	21,281,951	....
1853....	22	(b)	13,390,027	....	129,881	....	24,435,014	....
1854....	279	(b)	45,953,473	....	220,147	....	44,450,154	....
1855....	431	2,192	38,188,969	3,195,978	298,760	4,390,979	39,025,492	4,018,016
1856....	1,391	6,331	41,748,092	3,863,328	281,395	5,029,940	37,582,271	3,870,949
1857....	923	5,525	43,863,539	4,511,442	144,513	2,805,867	40,246,544	5,144,195
1858....	96,000	810,406	20,954,374	1,957,423	159,874	2,852,942	33,022,286	3,809,501
1859....	95,509	550,875	11,969,694	1,263,042	205,742	3,355,746	28,362,706	3,268,406
1860....	48,355	377,664	25,844,610	2,273,768	204,743	3,132,313	40,289,519	4,545,831
1861....	463	3,267	50,264,267	4,848,339	156,487	2,609,818	47,908,911	4,729,297
1862....	3,306	28,562	141,212,786	10,290,572	309,102	3,980,153	118,573,307	10,004,521
1863....	9,467	96,363	218,243,609	18,658,280	327,851	4,334,775	155,335,596	15,755,570
1864....	9,199	86,907	110,886,446	12,323,327	315,597	5,828,030	97,190,765	11,260,728
1865....	1,400	12,771	46,053,034	10,536,608	208,934	6,850,806	44,480,136	9,134,858
					Pounds.			
1866....	951	15,454	37,588,930	6,269,796	30,056,788	4,788,484	30,110,451	5,970,651
1867....	3,577	40,092	25,648,226	3,291,176	27,374,877	3,597,690	45,608,031	6,634,556
1868....	1,399	18,447	43,659,064	5,476,998	28,690,133	3,267,652	64,555,462	9,427,831
1869....	(b)	....	49,228,165	7,482,060	24,439,832	3,422,928	41,887,545	7,443,948
1870....	12,058	189,753	38,968,256	6,123,113	24,639,831	3,253,137	35,808,530	5,933,397
1871....	8,770	61,390	71,446,854	8,126,683	39,250,750	4,302,320	80,037,297	10,563,020
1872....	56,110	548,153	246,208,143	21,126,592	57,169,518	4,122,308	199,651,660	20,177,619
1873....	99,720	787,402	395,381,737	35,022,137	64,147,461	5,007,035	230,534,207	21,245,815
1874....	158,581	1,625,837	347,405,405	33,383,908	70,482,379	5,808,712	205,527,471	19,308,019
1875....	64,979	739,215	250,286,549	28,612,613	56,152,331	5,671,495	166,869,393	22,900,528
1876....	68,044	670,042	327,730,172	39,664,456	54,195,118	5,744,022	168,405,839	22,429,485
1877....	65,107	699,180	460,057,140	49,512,412	69,671,894	6,296,414	234,741,233	25,562,665
1878....	29,284	207,259	592,814,351	51,752,068	71,889,255	4,913,657	342,766,254	30,022,133
1879....	75,129	700,262	732,249,576	51,074,433	84,401,676	4,807,568	326,658,686	22,856,673
1880....	83,434	421,089	759,773,109	50,987,623	95,949,780	5,930,252	374,979,286	27,920,367
1881....	77,456	572,138	746,944,545	61,161,205	107,928,086	8,272,285	378,142,496	35,226,575
1882....	26,368	509,651	468,026,640	46,675,774	80,447,466	7,201,270	250,367,740	28,975,902
1883....	16,129	272,516	340,258,670	38,155,952	62,116,302	6,192,268	224,718,474	26,618,048
1884....	46,382	627,480	389,499,368	39,684,845	60,548,730	4,762,715	265,094,719	25,305,953
1885....	55,025	579,183	400,127,119	37,083,948	72,073,468	5,203,943	283,216,339	22,595,219
1886....	74,187	674,297	419,788,796	31,640,211	87,267,715	5,123,411	293,728,019	20,361,786

[a] For nine months only owing to change in fiscal year.

[b] None specified separately.

Total exports of hogs, hams and bacon, pork, and lard, etc.—Continued.

Fiscal year.	Live hogs.		Hams and bacon.		Pork.		Lard.	
	Number.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
		Dollars.		*Dollars.*		*Dollars.*		*Dollars.*
1887....	75,383	564,753	419,922,955	33,314,670	85,893,297	5,641,327	321,533,746	22,703,921
1888....	23,755	193,017	375,439,683	32,175,633	58,900,153	4,373,114	297,740,007	22,751,105
1889....	45,128	356,764	400,224,646	34,651,847	64,133,639	4,735,077	318,242,990	27,329,173
1890....	91,148	909,042	608,490,956	47,056,760	80,068,831	4,768,894	471,083,508	33,455,520
1891....	95,654	1,146,630	599,085,065	45,650,674	82,186,239	4,843,701	498,343,927	34,414,323
1892....	31,963	364,081	584,776,389	47,092,650	80,714,227	4,822,295	430,045,776	33,201,621
1893....	27,375	397,162	473,936,329	45,714,566	53,372,366	4,196,263	365,693,501	34,643,993
1894....	1,553	14,753	503,628,148	48,183,905	64,744,528	5,159,868	447,566,827	40,089,809
1895....	7,130	72,424	558,044,099	48,736,860	59,085,474	4,199,060	474,895,274	38,821,508
1896....	21,049	227,297	554,388,538	46,112,610	70,243,029	4,017,200	509,534,253	33,589,851
1897....	28,751	235,998	665,646,750	50,157,168	68,075,344	3,392,090	568,315,640	29,126,485
1898....	14,411	110,487	850,294,794	65,968,443	100,357,363	5,722,096	709,344,045	39,710,672
1899....	33,031	227,241	788,496,230	62,381,151	178,507,564	10,639,727	711,259,851	42,208,465
1900....	51,180	394,813	708,568,141	59,892,282	167,642,662	10,827,971	661,813,663	41,939,164
1901....	22,318	238,465	672,694,544	60,341,804	178,317,791	13,069,551	611,357,514	43,530,148
1902....	8,368	88,380	610,808,856	60,672,541	169,671,831	14,602,936	556,840,222	52,375,864
1903....	4,031	40,923	421,519,365	47,891,158	116,253,487	11,995,253	490,755,821	50,854,504

Exports of lard oil and bristles, 1855 to 1903.

Fiscal year.	Lard oil.		Bristles.	
	Gallons.	Value.	Pounds.	Value.
1855......	103,200	$82,945		
1856......	212,262	161,232		
1857......	91,432	92,499		
1858......	68,342	60,258		
1859......	56,675	50,793		
1860......	60,209	55,783		
1861......	85,676	81,783		
1862......	239,608	148,053		
1863......	1,259,063	983,349		
1864......	440,546	377,994		
1865......	100,520	157,671		
1866......	42,358	70,360		
1867......	144,158	176,363		
1868......	279,432	330,179		
1869......		97,370		$3,000
1870......	90,774	124,860		176
1871......	147,802	153,850		275
1872......	533,147	432,483		
1873......	388,836	298,731		3,150
1874......	252,577	203,317		14,210
1875......	146,594	147,384		640
1876......	146,323	149,156		10,460
1877......	247,305	281,551		22,770
1878......	1,553,314	986,561	a 60,267	17,600
1879......	1,963,208	1,067,923	80,140	22,350
1880.....	1,507,596	$816,447	b 97,505	$22,742
1881.....	836,255	558,576	29,707	8,722
1882.....	506,259	434,124	32,965	10,005
1883.....	379,205	353,184	83,047	10,053
1884.....	712,696	504,218	73,287	20,852
1885.....	916,157	555,426		
1886.....	973,229	500,011		
1887.....	975,163	519,274		
1888.....	930,616	509,514		
1889.....	861,303	542,897		
1890.....	1,214,611	683,343		
1891.....	1,092,448	562,986		
1892.....	907,575	496,601		
1893.....	486,812	336,613		
1894.....	681,081	449,571		1,844
1895.....	553,421	304,093		
1896.....	833,935	426,401		
1897.....	961,407	419,803		
1898.....	775,102	305,825		
1899.....	917,007	412,447		
1900.....	738,724	337,220		
1901.....	766,783	438,645		
1902.....	460,025	327,794		
1903.....	356,658	306,384		

a Quantity from Baltimore only; the value includes $10 worth from other ports.

b Quantity from Baltimore only; the value includes $245 worth from other ports.

The foregoing tables show clearly the growth of our foreign trade in hogs and hog products. There is a tendency to abandon the export trade in live hogs. In the early years of the country's existence a larger number of live hogs were often shipped abroad in one year than during the fiscal year ended June 30, 1903, and the relative importance of these shipments—such, for example, as 5,304 in 1790, 14,294 in 1800, and 22,294 in 1830—undoubtedly represents a much greater proportion of the hog output in those years than 4,031 in 1903 or 51,180 in 1900. The least number exported was 22, in 1853, except one year, 1869, when live hogs were not specified separately. The greatest number exported was in 1874, when 158,581 hogs were sold abroad. Since 1870 there has been more uniformity in this branch of the trade than before that date. Except during 1871, 1894, 1895, 1902, and 1903, the number exported has never fallen below 12,000, and, except in 1874, it has never exceeded 100,000.

Hams and bacon were included in the same column in the early reports, and, for sake of uniformity, this method is adhered to in this table. From the earliest times hams and bacon have figured prominently in our export trade. From 1790 to 1846 there is not a specially marked tendency to growth, but rather a steady maintenance of trade. The foreign trade consumed from 1,000,000 to 2,000,000 pounds annually, occasionally going below and often exceeding these figures, dropping to 138,556 pounds in 1814, during the second war with Great Britain, when the foreign trade in all kinds of hog products was affected, and reaching 3,886,976 pounds in 1844. The real growth of our export trade in hams and bacon began with the fiscal year ended June 30, 1847. From slightly over 3,000,000 pounds in 1846 the foreign trade consumed nearly 18,000,000 pounds in 1847, and, except in 1852, when these products fell below 6,000,000 pounds, no year shows sales so small as 11,000,000 pounds. This rapid development characterizes the foreign demand for all hog products and has two very well-marked periods—the first from 1847 to 1871, the second from 1872 to the present time. During the first period exports of hams and bacon exceeded 100,000,000 pounds only during three years of the Civil War period. During the second period, when artificial refrigeration has played so important a part in the commerce in meats, the trade has shown a fairly constant growth, starting with 246,208,143 pounds, valued at $21,126,592, in 1872, and reaching 850,294,794 pounds, valued at $65,368,443, in 1898.

Pork shows a greater growth prior to 1847 than hams and bacon. There is the same period of depression due to the suspension of commerce during the war of 1812–1815, and after that time a very considerable foreign trade. From 1847 to 1871 growth was rapid, the same decrease being apparent in 1852 and the same increase in 1862 to 1864. After 1872 the lowest amount exported was 53,372,366 pounds, valued at $4,196,263, in 1893; the greatest amount was 178,507,564 pounds in 1899, valued at $10,639,727, and the greatest value was for 1902—169,671,831 pounds, valued at $14,602,936.

Prior to 1847 lard shows more growth than the other hog products. It was also least affected by the war of 1812–1815. In the year 1847 the same increase may be noticed and the same depression in the early fifties. There is also the same increase during the civil war. From 1871 to 1872 lard shows an increase of 150 per cent in the foreign trade, as compared with an increase of more than 240 per cent in that of hams and bacon and over 45 per cent in that of pork. From a foreign consumption of 199,651,660 pounds in 1872, valued at $20,177,619, the lard exports reached their maximum quantity in 1899, with 711,259,851 pounds, valued at $42,208,465, and their maximum value in 1902, with 556,840,222 pounds, valued at $52,375,864.

Lard oil does not figure in the exports until 1855, when 103,200 gallons, valued at $82,945, were exported. The rapid development of the early seventies is also seen in the exports of this product. The greatest amount was shipped in 1879—1,963,208 gallons, valued at $1,037,923, which was also the greatest value for any year.

Averages of five-year periods.—The following table shows the average annual exports of hog products from 1873 to 1902, inclusive, arranged in five-year periods:

Exports of hog products from the United States, average of five-year periods, 1873 to 1902.

Fiscal years.	Hams and bacon.		Pork.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*
1873–1877	356,172,201	37,239,105	62,929,837	5,705,538
1878–1882	659,961,644	52,330,221	88,123,253	6,225,006
1883–1887	393,919,382	35,975,925	73,579,902	5,384,733
1888–1892	513,603,468	41,325,513	73,190,518	4,708,616
1893–1897	551,128,773	47,781,022	63,104,148	4,192,884
1898–1902	726,171,913	61,621,244	158,899,442	10,970,444

Fiscal years.	Lard.		Lard oil.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Gallons.*	*Dollars.*
1873–1877	201,215,629	22,289,301	256,327	216,028
1878–1882	334,582,892	29,000,330	1,273,326	766,726
1883–1887	277,658,259	23,516,985	791,290	486,423
1888–1892	409,091,260	30,230,348	1,001,311	555,068
1893–1897	473,201,108	34,854,329	703,331	387,296
1898–1902	650,123,059	44,558,863	731,530	364,394

These figures bring out much more clearly the rapid growth of our foreign trade. The annual amount of hams and bacon, pork, and lard oil exported have more than doubled since the five-year period of 1873–1877, while the lard exports have more than tripled in this time.

IMPORTS OF HOGS AND HOG PRODUCTS.

The following table shows the total imports of hogs and hog products into the United States since and including the year 1824:

Imports of hams and bacon, pork, and lard into the United States.

Fiscal year.[a]	Hams and bacon.[b]		Pork.[c]		Lard.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
1824	6,272	422	279	19	....	....
1825	15,626	1,244	263,634	5,294	....	....
1826	43,525	3,679	738,156	23,982	....	....
1827	5,214	503	208,831	8,049	242	41
1828	3,894	343	461,143	22,094	1,648	88
1829	9,526	1,073	430,166	17,598	147	16
1830	7,617	681	659,099	28,220	135	10
1831	27,757	2,506	335,922	6,690	5,778	451
1832	24,305	2,204	90,837	2,115	723	41
1833	14,881	1,691	379,270	11,748	1,031	90
1834	29,950	3,189	1,196,609	37,102	....	....
1835	65,625	5,739	....	....	....	....
1836	173,945	16,244	75,311	4,226	210,073	27,631
1837	219,634	22,018	158,639	11,854	52,372	5,239
1838	215,268	20,959	990,768	26,570	80	9
1839	316,492	32,539	777,531	23,734	13,375	1,437
1840	122,481	14,087	467,916	12,432	98	7
1841	120,878	13,420	158,174	3,629	80	5
1842	59,384	6,232	186,973	3,154	40	3
1843[d]	26,815	2,731	359,801	5,984	....	....
1844	26,499	3,222	259,379	6,812	47	3
1845	30,968	3,540	27,866	1,068	....	....
1846	36,936	4,276	11,639	776	1,524	191
1847	21,356	2,880	29,364	1,908	850	17
1848	18,135	2,769	43,530	2,688	8,100	715
1849	23,188	2,268	25,184	1,515	249	14
1850	105,059	9,381	241,883	7,503	48	2
1851	136,273	13,456	41,276	1,667	2,672	131
1852	177,169	13,358	646,722	31,778	61,068	5,967
1853	81,149	7,455	748,300	26,766	16,130	946
1854	68,691	8,419	212,040	12,723	150,868	19,728
1855	75,216	9,411	158,397	6,194	104,068	9,329
1856	68,405	9,551	7,054	622	4,568	493
1857	48,263	7,204	36,323	2,614	362,931	28,046
1858	70,948	9,054	11,956	595	67,666	8,040
1859	85,623	12,197	12,348	1,340	12,165	1,378
1860	118,904	16,020	15,288	841	23,201	2,431
1861	77,639	11,055	2,548	151	199,754	9,627
1862	52,770	5,866	....	....	[e]271,529	21,239

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[a] The fiscal year ended September 30, up to and including 1842; thereafter, June 30.

[b] From 1828 to 1842, inclusive, bacon only reported.

[c] Includes beef from 1824 to 1857 and from 1865 to 1871.

[d] For nine months only, owing to change of fiscal year.

[e] Includes tallow.

Imports of hams and bacon, pork, and lard into the United States—Continued.

Fiscal year.	Hams and bacon.		Pork.		Lard.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
1863	51,421	7,357	----------	----------	[a] 250,343	20,213
1864	----------	----------	----------	----------	[a] 220,081	17,733
1865	122,573	13,020	12,252	927	272,111	33,117
1866	80,079	11,440	151,323	11,684	[b] 22,895	31,660
1867 [c]	116,520	15,046	[c] 745,496	46,924	9,800	1,163
1868	142,884	20,692	530,512	36,991	2,808	294
1869	151,281	23,369	426,659	29,897	6,018	1,080
1870	138,600	22,177	840,074	60,340	19,956	2,927
1871	144,150	23,504	997,257	70,291	9,565	1,478
1872	165,170	32,445	98,854	7,562	11,770	2,801
1873	118,852	21,828	90,214	5,722	3,050	548
1874	105,596	18,440	33,696	2,435	2,563	503
1875	96,254	17,577	19,649	1,717	1,882	268
1876	75,468	12,507	46,137	3,248	12,816	1,327
1877	73,774	14,193	42,428	3,112	12,524	1,167
1878	67,987	11,886	31,771	1,844	2,295	228
1879	56,305	9,774	31,181	1,476	1,500	170
1880	88,447	12,304	30,446	1,770	712	75
1881	77,423	14,341	28,647	2,026	1,655	225
1882	74,182	14,190	33,266	2,721	2,944	386
1883	107,810	21,181	50,651	4,509	1,387	200
1884	134,554	24,315	27,393	2,269	1,021	122
1885	139,158	23,893	45,165	2,975	561	62
1886	152,875	27,010	37,529	2,367	489	53
1887	191,378	32,537	28,831	1,591	782	83
1888	214,078	35,447	18,019	1,132	1,263	136
1889	272,130	45,900	13,719	978	1,073	88
1890	251,080	48,366	10,127	621	1,524	122
1891	211,332	39,892	11,267	808	1,795	187
1892	230,145	43,532	13,804	997	1,945	222
1893	247,784	47,540	12,822	1,054	6,051	510
1894	215,340	40,006	8,668	679	2,065	245
1895	265,264	45,716	12,245	835	2,015	210
1896	275,503	44,906	29,847	1,560	2,116	201
1897	253,683	40,346	9,660	543	1,423	139
1898	280,140	47,903	7,302	636	5,147	314
1899	265,245	45,833	16,628	1,585	1,766	181
1900	287,697	50,009	24,203	2,765	8,291	1,807
1901	285,942	50,505	11,663	1,116	3,084	290
1902	387,348	71,764	12,652	1,076	2,260	187
1903 [d]	----------	----------	----------	----------	----------	----------

[a] Includes tallow.

[b] Quantity not given for Canada.

[c] From 1867 to 1902 the imports are for home consumption, prior to 1867 they are the total imports.

[d] Imports of meat products of hogs were not separately enumerated for this year.

The imports of bristles into the United States from 1816 to the present time are also presented here as affording opportunity for some interesting comparisons.

Imports of bristles, 1816 to 1903.

Fiscal year.[a]	Quantity.	Value.	Fiscal year.	Quantity.	Value.	Fiscal year.	Quantity.	Value.
	Pounds.	*Dollars.*		*Pounds.*	*Dollars.*		*Pounds.*	*Dollars.*
1816	4,731	....	1846	445,725	244,719	1876	588,834	622,178
1817	88,809	....	1847	420,682	191,473	1877	450,056	536,460
1818	99,810	....	1848	485,661	175,025	1878	623,670	662,937
1819	144,726	....	1849	221,045	88,265	1879	417,234	474,368
1820	....	....	1850	303,613	152,702	1880	984,285	1,009,495
1821	84,867	....	1851	465,645	244,694	1881	838,840	911,519
1822	203,472	....	1852	464,918	313,130	1882	862,072	1,032,355
1823	91,389	....	1853	389,200	253,731	1883	1,020,999	1,228,543
1824	184,432	....	1854	659,353	349,154	1884	988,736	1,201,735
1825	175,346	56,606	1855	507,847	315,113	1885	790,502	926,749
1826	121,852	49,069	1856	376,869	243,964	1886	1,076,330	1,087,137
1827	252,181	85,433	1857	470,845	289,581	1887	1,196,242	1,174,333
1828	404,847	132,242	1858	443,727	265,720	1888	1,114,214	1,215,325
1829	103,958	26,414	1859	329,063	222,179	1889	1,330,787	1,284,724
1830	115,551	26,518	1860	626,810	437,450	1890	1,261,609	1,286,219
1831	245,486	74,776	1861	569,311	396,871	1891	1,404,832	1,357,968
1832	410,206	110,722	1862	137,776	108,780	1892	1,495,003	1,455,058
1833	273,769	101,293	1863	271,851	218,279	1893	1,596,818	1,508,258
1834	146,514	69,337	1864	264,532	222,164	1894	892,520	929,231
1835	98,487	53,107	1865	266,827	220,004	1895	1,301,494	1,244,151
1836	362,169	216,034	1866	1,131,366	674,938	1896	1,572,530	1,435,348
1837	250,599	142,740	1867	831,422	689,390	1897	1,347,900	1,217,179
1838	115,190	30,413	1868	520,355	556,097	1898	1,535,090	1,249,119
1839	497,339	195,026	1869	....	589,135	1899	1,856,577	1,458,252
1840	235,799	94,325	1870	....	629,057	1900	2,530,158	2,152,867
1841	297,806	150,130	1871	....	727,588	1901	1,684,575	1,780,197
1842	....	74,395	1872	588,181	781,238	1902	2,013,109	2,047,331
1843[b]	26,695	8,271	1873	632,203	811,322	1903	3,043,865	2,654,604
1844	190,638	84,011	1874	522,006	645,102			
1845	343,218	172,076	1875	495,054	627,845			

[a] The fiscal year ended September 30, up to and including 1842; thereafter, June 30.
[b] For nine months only, owing to change in fiscal year.

The Treasury statistics do not give the importations of live hogs separately. The number imported during recent years is shown by the records of the Inspection Division of the Bureau of Animal Industry. Since the establishment of inspections November 15, 1890, these are as follows:

Imports of live hogs.

Fiscal year.	Canada.	Mexico.	Atlantic seaboard.	Total.
November 15, 1890, to June 30, 1891	29	....	70	99
1892	74	....	2	76
1893	16,008	....	24	16,032
1894	1,302	....	43	1,345
1895	908	....	23	931
1896	216	42	30	288
1897	212	12	55	279
1898	375	104	10	489
1899	196	64	47	307
1900	1,096	44	2	1,142
1901	443	....	74	[a]517
1902	5,370	64	12	5,453

[a] Including 7 hogs quarantined at San Francisco.

IMPORTS OF PORK PRODUCTS INTO THE UNITED KINGDOM.

The following table has been compiled from British trade reports to show the relative importance of American hog products on that market.[a] As the United Kingdom imports bacon to a greater extent than any other hog meat, and as the English figures show very striking comparisons between American bacon and that from other sources, this table has been arranged to show the British imports since 1888, the year that the bacon imports from Denmark, our strongest competitor, were first reported separately. The figures show total quantities, total values, and values per 100 pounds.

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[a] In comparing the English import figures of pork products with the United States export statistics discrepancies will be noticed, especially in the commerce in bacon and pork ("fresh and salted"). As the accuracy of the figures are not to be questioned in either case, the following explanation from the reports of the British Board of Trade is interesting: "A considerable amount of Canadian produce finds its way to the United Kingdom via the ports of the United States in winter, when many Canadian ports are closed by ice. To a limited extent produce from the United States is sent to the United Kingdom via Canadian ports in the summer. Where, in such cases, the official documents enable a distinction to be drawn between Canadian and United States produce it is credited to the true country of origin. But in many cases such a distinction can not be made, so that in using the statistics it should be remembered that a certain amount of the trade of Canada with this country, especially in winter, is unavoidably included under the heading 'United States.'"—(Trade and Navigation of the United Kingdom, December, 1899, pp. II, III.)

Imports of pork products into the United Kingdom, 1888 to 1902.

[From Trade and Navigation, published by the British Government.]

Article and country.	1888.			1889.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	21,416,416	2,107,467	9.84	10,081,680	1,061,496	10.53
Belgium	3,913,168	399,691	10.21	1,672,048	183,102	10.95
United States	896	88	9.82	784	49	6.25
Other countries	1,860,656	203,172	10.92	1,332,240	147,849	11.10
Total	27,191,136	2,710,418	9.97	13,086,752	1,392,496	10.64
Bacon:						
Denmark	58,371,376	6,689,778	11.46	64,434,048	7,979,858	12.38
United States	208,894,560	18,750,435	8.98	285,336,016	23,410,094	8.20
Other countries[a]	52,442,096	5,671,122	10.81	42,022,064	4,073,241	9.69
Total	319,708,032	31,111,335	9.73	391,792,128	35,463,193	9.05
Hams:						
United States	72,427,264	8,257,823	11.40	97,810,048	10,789,454	11.03
Other countries	9,142,896	1,105,012	12.09	11,682,048	1,384,018	11.85
Total	81,570,160	9,362,835	11.48	109,492,096	12,173,472	11.12
Pork, salted (not bacon or hams):						
United States	16,746,800	1,156,441	6.91	21,477,904	1,376,324	6.41
Other countries	10,680,992	595,115	5.57	8,715,840	522,901	6.00
Total	27,427,792	1,751,556	6.39	30,193,744	1,899,225	6.29

Article and country.	1890.			1891.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	2,911,328	301,485	10.36	10,092,768	1,049,553	10.40
Belgium	1,219,456	133,328	10.93	3,508,064	367,606	10.48
United States	6,720	457	6.80	(b)	....	....
Other countries	935,536	99,238	10.61	681,184	56,052	8.23
Total	5,073,040	534,508	10.54	14,282,016	1,473,211	10.32
Bacon:						
Denmark	52,176,992	6,492,378	12.44	65,057,216	7,703,076	11.84
United States	328,660,080	23,802,013	7.24	299,606,048	21,985,217	7.34
Canada	(b)	....	....	16,924,208	1,382,646	8.17
Other countries[a]	43,706,768	3,664,343	8.38	11,555,936	1,292,864	11.19
Total	424,543,840	33,958,734	8.09	393,143,408	32,363,803	8.23
Hams:						
United States	122,570,896	12,573,795	10.26	125,041,392	12,558,359	10.04
Canada	....	....	....	9,372,160	955,274	10.19
Other countries	12,887,056	1,388,753	10.78	524,384	70,895	13.52
Total	135,457,952	13,962,548	10.31	134,937.936	13,584,528	10.07
Pork, salted (not bacon or hams):						
United States	22,912,624	1,373,200	5.99	19,048,400	1,132,692	5.95
Other countries	5,631,360	288,340	5.12	6,352,976	307,461	4.84
Total	28,543,984	1,661,540	5.82	25,401,376	1,440,153	5.67

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[a] In 1888 Germany exported to the United Kingdom 28,337,792 pounds of bacon, valued at $3,244,004, which is equivalent to $11.45 per 100 pounds. In 1889 the amount dropped to 7,127,568 pounds, and in 1890 to 155,680 pounds, and since that time small quantities have annually appeared until 1897, when they were dropped from the returns.

[b] Not separately enumerated.

Imports of pork products into the United Kingdom, 1888 to 1902—Continued.

Article and country.	1892.			1893.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	10,394,496	1,042,487	10.03	13,568,464	1,414,142	10.42
Belgium	2,522,464	271,249	10.75	2,826,096	308,643	10.92
Other countries	1,879,024	195,682	10.41	4,111,632	494,120	12.02
Total	14,795,984	1,509,418	10.20	20,506,192	2,216,905	10.81
Bacon:						
Denmark	75,250,784	9,340,746	12.41	79,727,648	10,453,914	13.11
United States	324,346,512	26,057,212	8.03	243,856,816	26,879,855	11.02
Canada	26,781,552	2,251,467	8.41	21,702,576	2,409,725	11.10
Other countries[a]	8,335,488	942,510	11.31	12,988,304	1,523,526	11.73
Total	434,714,336	38,591,935	8.88	358,275.344	41,267,020	11.52
Hams:						
United States	126,708,248	12,988,314	10.25	103,147,632	13,074,548	12.68
Canada	12,790,176	1,322,150	10.34	6,471,360	837,758	12.95
Other countries	857,360	112,440	13.11	1,083,040	153,105	14.14
Total	140,350,784	14,422,904	10.28	110,702,032	14,065,411	12.71
Pork, salted (not bacon or hams):						
United States	18,168,640	1,135,564	6.25	12,186,832	950,140	7.80
Other countries	7,407,008	354,860	4.79	8,748,320	459,086	5.25
Total	25,575,648	1,490,424	5.83	20,935,152	1,409,226	6.73

Article and country.	1894.			1895.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	14,954,912	1,540,121	10.30	27,521,312	2,768,401	10.06
Belgium	3,425,520	374,896	10.94	3,040,800	327,418	10.77
Other countries	1,822,464	209,435	11.49	1,725,696	140,141	8.12
Total	20,202,896	2,124,452	10.52	32,287,808	3,235,960	10.02
Bacon:						
Denmark	85,884,736	10,655,640	12.41	113,560,160	12,189,108	10.73
United States	286,854,736	24,736,181	8.62	296,741,984	22,318,202	7.52
Canada	28,497,616	2,557,117	8.97	30,115,232	2,437,314	8.09
Other countries[a]	11,998,560	1,391,298	11.60	14,685,440	1,627,153	11.08
Total	413,235,648	39,340,236	9.52	455,102,816	38,571,777	8.48
Hams:						
United States	120,430,240	12,805,085	10.63	134,753,584	13,127,316	9.74
Canada	5,664,512	619,291	10.93	9,151,184	905,855	9.90
Other countries	441,056	64,724	14.68	521,248	70,034	13.44
Total	126,535,808	13,489,100	10.66	144,426,016	14,103,205	9.77
Pork, salted (not bacon or hams):						
United States	16,820,832	1,152,767	6.85	13,765,024	828,882	6.02
Other countries	8,381,296	480,216	5.73	10,893,792	484,241	4.45
Total	25,202,128	1,632,983	6.48	24,658,816	1,313,123	5.33

[a] See note [a], page 272.

Imports of pork products into the United Kingdom, 1888 to 1902—Continued.

Article and country.	1896. Quantity.	1896. Value.	1896. Value per 100 pounds.	1897. Quantity.	1897. Value.	1897. Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	27,366,528	2,708,339	9.90	25,336,080	2,378,526	9.39
Belgium	4,391,296	478,572	10.90	4,125,184	450,492	10.92
United States						
Other countries	1,776,208	157,548	8.87	9,471,840	894,477	9.34
Total	33,534,032	3,344,459	9.97	38,933,104	3,723,495	9.56
Bacon:						
Denmark	136,876,768	13,586,266	9.93	114,973,824	13,355,769	11.62
United States	308,170,016	19,790,634	6.42	402,375,120	26,053,411	6.47
Canada	51,152,976	3,385,347	6.62	32,511,696	2,546,128	7.83
Other countries[a]	13,347,152	1,461,751	10.95	10,689,846	1,200,064	11.23
Total	509,546,912	38,223,998	7.50	560,550,486	43,155,372	7.70
Hams:						
United States	144,029,312	13,424,114	9.32	179,595,696	16,602,352	9.24
Canada	18,958,912	1,778,326	9.38	13,342,896	1,266,614	9.49
Other countries	465,920	59,337	12.74	359,408	49,322	13.72
Total	163,454,144	15,261,777	9.34	193,298,000	17,918,288	9.27
Pork, salted (not bacon or hams):						
United States	15,419,376	856,888	5.56	15,839,936	815,139	5.15
Other countries	13,178,592	563,964	4.28	10,727,136	419,458	3.91
Total	28,597,968	1,420,852	4.97	26,567,072	1,234,597	4.65

Article and country.	1898. Quantity.	1898. Value.	1898. Value per 100 pounds.	1899. Quantity.	1899. Value.	1899. Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	24,939,264	2,308,969	9.26	38,566,752	3,541,045	9.18
Belgium	3,931,424	429,508	10.92	3,958,304	447,699	11.31
United States				31,006,528	2,692,907	8.68
Other countries	33,580,736	2,932,845	8.73	1,393,280	146,248	10.50
Total	62,451,424	5,671,322	9.08	74,924,864	6,827,899	9.11
Bacon:						
Denmark	113,962,240	13,144,962	11.53	135,588,544	14,335,526	10.57
United States	457,787,568	31,331,690	6.84	457,917,152	31,886,184	6.96
Canada	60,018,448	4,845,209	8.07	50,822,576	3,707,597	7.30
Other countries[a]	7,899,808	908,566	11.50	5,785,024	685,223	11.84
Total	639,668,064	50,230,427	7.85	650,113,296	50,614,530	7.79
Hams:						
United States	207,370,240	17,769,606	8.57	204,284,080	18,400,271	9.01
Canada	13,151,936	1,135,218	8.63	16,878,176	1,465,848	8.68
Other countries	375,312	49,410	13.17	443,856	59,765	13.46
Total	220,897,488	18,954,234	8.58	221,606,112	19,925,884	8.99
Pork, salted (not bacon or hams):						
United States	19,600,000	1,092,695	5.57	18,372,704	972,570	5.30
Other countries	11,311,216	463,505	4.10	13,515,936	515,747	3.82
Total	30,911,216	1,556,200	5.03	31,888,640	1,488,317	4.67

[a] See note [a], p. 272.

Imports of pork products into the United Kingdom, 1888 to 1902—Continued.

Article and country.	1900.			1901.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	43,588,608	4,009,149	9.20	42,230,832	3,896,748	9.23
Belgium	5,771,024	618,084	10.71	4,533,984	477,511	10.53
United States	26,676,048	2,445,991	9.17	39,080,720	3,713,105	9.50
Other countries	1,848,560	204,106	11.04	2,803,472	261,764	9.34
Total	77,884,240	7,277,830	9.34	88,649,008	8,349,128	9.42
Bacon:						
Denmark	122,598,112	14,885,563	12.14	118,821,808	15,740,480	13.25
United States	443,131,024	36,459,541	8.23	475,364,848	45,043,599	9.48
Canada	59,344,768	5,233,653	8.82	44,654,064	4,484,524	10.04
Other countries[a]	6,744,752	719,264	10.66	7,662,256	867,989	11.33
Total	631,818,656	57,298,021	9.07	646,502,976	66,136,592	10.23
Hams:						
United States	179,474,736	18,311,248	10.20	193,820,032	20,487,070	10.57
Canada	21,972,384	2,175,043	9.90	14,097,104	1,483,416	10.52
Other countries	451,920	59,143	13.09	477,904	66,914	14.00
Total	201,899,040	20,545,434	10.18	208,395,040	22,037,400	10.57
Pork, salted (not bacon or hams):						
United States	14,381,024	864,636	6.01	15,420,160	1,011,531	6.56
Other countries	13,476,512	601,879	4.47	12,249,440	566,032	4.62
Total	27,857,536	1,466,515	5.26	27,669,600	1,577,563	5.70

Article and country.	1902.		
	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*
Holland	39,580,576	3,660,041	9.25
Belgium	3,881,472	407,433	10.50
United States	28,271,152	2,785,234	9.85
Other countries	1,668,912	184,956	11.08
Total	73,402,112	7,037,664	9.59
Bacon:			
Denmark	140,630,224	18,245,034	12.97
United States	367,791,760	40,097,634	10.90
Canada	51,798,544	5,855,762	11.30
Other countries[a]	9,826,320	1,143,905	11.64
Total	570,046,848	65,342,335	11.46
Hams:			
United States	147,031,248	16,653,182	11.33
Canada	18,360,160	2,045,482	11.14
Other countries	624,736	81,168	12.99
Total	166,016,144	18,779,832	11.31
Pork, salted (not bacon or hams):			
United States	11,807,264	910,688	7.71
Other countries	11,182,416	576,452	5.15
Total	22,989,680	1,487,140	6.47

[a] See note a, p. 272.

Referring to the imports for the year ended December 31, 1902, we see that of the total imports into the United Kingdom of meat products of hogs there were imported 73,402,112 pounds of fresh pork, or 8.82 per cent of the total amount, valued at $7,037,664, or $9.59 per 100 pounds; 570,046,848 pounds of bacon, 68.61 per cent of the total amount, valued at $65,342,335, or $11.46 per 100 pounds; 166,016,144 pounds of hams, which were 19.94 per cent of the total, and valued at $18,779,832, or $11.31 per 100 pounds, and 22,989,680 pounds of salted pork (not bacon or hams), which were 2.63 per cent of the total amount of meat products of hogs imported, and were valued at $1,487,140, an average value per 100 pounds of $6.47.

Except for very small amounts, fresh pork from the United States was first reported separately in 1899, when 31,006,528 pounds, valued at $2,692,907, were imported. The bulk of this product now reaches the United Kingdom from Holland and the United States, Holland furnishing a somewhat larger amount, which generally, although not always, sells for slightly more than the fresh pork from America. In quality the Belgian fresh pork is ranked higher than that from either Holland or the United States, but the imports from that source do not form a very large proportion of the total of the fresh pork imported in 1902. Holland furnished 39,580,576 pounds, or 53.92 per cent, valued at $3,660,041, and the United States furnished 28,271,152 pounds, or 38.52 per cent of the total amount, and valued at $2,785,234; Belgium furnished 3,881,472 pounds, or 5.29 per cent, valued at $407,433. The value per 100 pounds of the pork from Belgium was $10.50, that from Holland $9.25, and that from the United States $9.85.

The United States is easily the principal source of hams that are imported into the United Kingdom. Until 1891 this country was the only one whose imports were separately enumerated. For that year Canada is reported with 9,372,160 pounds, valued at $955,274, which is $10.19 per 100 pounds. Until 1899 the Canadian hams had a greater value per 100 pounds than those of the United States, since which date the hams from the United States have had the greater value per 100 pounds. There were imported in 1902, 166,016,144 pounds of hams, of which the United States furnished 147,031,248 pounds, or 88.56 per cent; Canada furnished 18,360,160 pounds, or 11.06 per cent.

Although there has not been a marked tendency toward decreased importations of salted pork (not bacon or hams) from the United States, other countries not enumerated are gradually selling the United Kingdom a larger proportion of this product. In 1902 there were credited to the United States 11,807,264 pounds, or 51.37 per cent of the total amount imported, valued at $910,688. The value per 100 pounds of the United States product in 1902 was $7.71, which is $1.24 above the average value per 100 pounds of all imported.

Attention is now called to the imports of bacon into the United

Kingdom. As is well known, the English people consume large quantities of bacon, and are generally regarded as being accurate judges of this product, the English market being the most critical in the world for bacon. While the highest prices are supposed to be obtained by the native Wiltshire and the Irish bacon, great quantities are imported, bacon comprising 68.61 per cent of the total imports of meat products of hogs in 1902. In the year ended December 31, 1902, the United States supplied 367,791,760 pounds of the total amount of bacon imported, which had a total value of $40,097,634 and an average value per 100 pounds of $10.90. This was 64.52 per cent of the total amount and 61.36 per cent of the total value of bacon imported. From Denmark 140,630,224 pounds were imported—24.67 per cent of the total amount—with a valuation of $18,245,034, 27.92 per cent of the total value, and an average value per 100 pounds of $12.97. Canada is credited with 51,798,544 pounds—9.09 per cent of the total amount—valued at $5,855,762, or 8.97 per cent of the total value, and an average value per 100 pounds of $11.30. A more careful examination of the table shows that never since Danish or Canadian bacon have been separately reported in the British customs reports have the prices per 100 pounds for bacon from the United States been equal to that of the bacon from these countries, the difference between United States bacon and Danish bacon being particularly striking in this respect. This discrimination against the bacon from this country is not a new subject for discussion. In his report for 1894 the Secretary of Agriculture called particular attention to the need of careful study by the producers in the United States if they wished to supply this market with a product that is really desirable according to the English standards, and the subject has often been referred to in the press.

During the fifteen years for which we have figures regarding Danish bacon the valuation per 100 pounds has been less than $11 in three years only (1895, 1896, and 1899), and in one year only (1896) has it fallen below $10, when a valuation of $9.93 was reached. In the years 1893 and 1901 it was more than $13. On the other hand, in the years 1893, 1901, and 1902 only has bacon from the United States had a valuation of more than $9 per 100 pounds, and in the years 1893 and 1902 only, when extremely high prices were recorded in this country for live hogs, has the valuation been in the neighborhood of $11 per 100 pounds, being $11.02 and $10.90, respectively, in these years. In no year has it sold up to the average valuation per 100 pounds of the total imports of bacon into the United Kingdom. In three years—1888, 1893, and 1902, all years of high prices in this country—the difference in value per 100 pounds between Danish and United States bacon has been less than $2.50, as follows: 1888, $2.48; 1893, $2.09; 1902, $2.07. In 1895 the difference was less than $3.50, but in all other years it was more than $3.50, a difference of more than $4 being noticed in the years 1889, 1890, 1891, 1892, 1897, and

1898, and a difference of over $5 in the years 1890 and 1897. The greatest difference was in 1890, when the Danish bacon averaged $5.20 per 100 pounds more than that from this country. The average valuation per 100 pounds of all bacon imported into the United Kingdom for the entire period from 1888 to 1902 was $8.94; that of the United States bacon was $8.07, and that of the Danish bacon, $11.83, a difference of $3.76 in favor of the Danish bacon.

A further evidence of the fact that Danish bacon stands higher in the esteem of the English people than that produced in the United States is that there is less fluctuation in its value in periods of greatest supply. If we take the periods immediately preceding the years 1893 and 1902, when the prices of hogs reached extreme points in the United States, and exports from this country diminished very noticeably, we find a range in value per 100 pounds in the Danish bacon from $11.46 to $12.44 during the years 1888 to 1892, a fluctuation of $0.98, and during the years 1894 to 1901, a range from $9.93 to $13.25, a difference of $3.32. The values reached during the years 1893 and 1902, immediately following the above periods, were $13.11 and $12.97, respectively, the year 1902 showing a slight decrease in the value of the Danish product. The extreme range including the year of highest value is $1.65 during the years from 1888 to 1893. The extreme range during the later period is $3.32, and is shown by the returns for the years 1896 and 1901. During these two periods the United States bacon ranged in valuation from $7.24 to $8.98 in the years 1888 to 1892 and reached a valuation per 100 pounds of $11.02 in 1893, showing a fluctuation in normal years of $1.74 and an extreme fluctuation of $3.78. During the years 1894 to 1901 the range is from $6.42 in 1896 to $9.48 in 1901, the extreme of $10.90 being reached in 1902, thus showing a fluctuation in normal years of $3.06, and an extreme fluctuation, including the year of scarcity of supply and high prices, of $4.48.

These figures would seem to indicate that the Danish bacon is a finer product than the United States bacon; that a more constant demand exists for it on the English market, and that it supplies a finer trade than bacon from the United States. It is evident that the English people buy American bacon because it is in abundance and cheap in price, and they only pay well for it when forced to do so by scarcity and high prices in the country of production.

A somewhat surprising feature that is shown by these figures is the rating of bacon from Canada, which, while it shows a higher rating on the English market than the United States bacon, does not greatly exceed the average valuation from year to year, and seems to be affected by conditions similar to those that govern the valuations of the bacon from the United States. During the years 1888–1902 the average valuation of the Canadian bacon imported into the United Kingdom was $8.96—2 cents per 100 pounds more than the average and 89 cents more than the United States bacon, but $2.87 less than that from Denmark.

MISCELLANEOUS TRADE STATISTICS.

Having devoted attention to the total production and foreign trade of hogs and hog products, it is of much interest to study the figures showing the stocks in the country after the foreign demand and the local consumption have been supplied. The total production, less the sum of the foreign consumption during a given period, and the stocks on hand at the close of the period will represent quite accurately the home consumption for that period. The following table gives a comparison of the aggregate stocks of hog meats (including pork) and lard in the West, in the East, and in transit on March 1 for the years of 1881 to 1903, inclusive:

Comparison of the aggregate of meats (including pork) and lard in the West, in the East, and in transit on March 1, 1881 to 1903.

[Cincinnati Price Current.]

Year.	Meats and pork.	Lard.	Total product.	Year.	Meats and pork.	Lard.	Total product.
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
1881	414,000,000	86,000,000	500,000,000	1893....	299,000,000	22,000,000	321,000,000
1882	406,000,000	106,000,000	512,000,000	1894....	336,000,000	24,000,000	360,000,000
1883	445,000,000	88,000,000	533,000,000	1895....	555,000,000	48,000,000	603,000,000
1884	329,000,000	81,000,000	410,000,000	1896....	476,000,000	74,000,000	550,000,000
1885	427,000,000	76,000,000	503,000,000	1897....	510,000,000	134,000,000	644,000,000
1886	453,000,000	99,000,000	552,000,000	1898....	591,000,000	94,000,000	685,000,000
1887	396,000,000	78,000,000	474,000,000	1899....	696,000,000	97,000,000	793,000,000
1888	408,000,000	61,000,000	469,000,000	1900....	511,000,000	72,000,000	583,000,000
1889	380,000,000	42,000,000	422,000,000	1901....	519,000,000	41,000,000	560,000,000
1890	426,000,000	53,000,000	479,000,000	1902....	565,000,000	52,000,000	617,000,000
1891	686,000,000	113,000,000	799,000,000	1903....	446,000,000	29,000,000	475,000,000
1892	611,000,000	80,000,000	691,000,000				

APPARENT DOMESTIC CONSUMPTION OF MEAT PRODUCTS OF HOGS.

The following table is an estimate of the apparent annual domestic consumption of the meat products of hogs, including barreled pork, also the monthly average, for 1890 to 1903:

Apparent domestic consumption of meat products of hogs (including barreled pork) from 1891 to 1903.

[Cincinnati Price Current.]

SUMMER SEASON—MARCH 1 TO NOVEMBER 1.

Year.	Total.	Monthly average.
	Pounds.	*Pounds.*
1902	1,767,000,000	221,000,000
1901	1,809,000,000	226,000,000
1900	1,802,000,000	225,000,000
1899	1,857,000,000	232,000,000
1898	1,756,000,000	219,000,000
1897	1,578,000,000	197,000,000
1896	1,468,000,000	183,000,000
1895	1,327,000,000	166,000,000
1894	1,222,000,000	153,000,000
1893	1,060,000,000	132,000,000
1892	1,429,000,000	179,000,000
1891	1,346,000,000	168,000,000

Apparent domestic consumption of meat products of hogs, etc.—Continued.

WINTER SEASON—NOVEMBER 1 TO MARCH 1.

Year.	Total.	Monthly average.
	Pounds.	*Pounds.*
1902-03	797,000,000	199,000,000
1901-02	807,000,000	202,000,000
1900-01	834,000,000	216,000,000
1899-00	842,000,000	210,000,000
1898-99	787,000,000	197,000,000
1897-98	730,000,000	182,000,000
1896-97	652,000,000	163,000,000
1895-96	623,000,000	156,000,000
1894-95	603,000,000	151,000,000
1893-94	504,000,000	126,000,000
1892-93	513,000,000	128,000,000
1891-92	807,000,000	202,000,000

TWELVE MONTHS ENDED MARCH 1.

1902-03	2,564,000,000	213,000,000
1901-02	2,630,000,000	219,000,000
1900-01	2,666,000,000	222,000,000
1899-00	2,699,000,000	225,000,000
1898-99	2,543,000,000	212,000,000
1897-98	2,308,000,000	192,000,000
1896-97	2,120,000,000	177,000,000
1895-96	1,950,000,000	162,000,000
1894-95	1,825,000,000	152,000,000
1893-94	1,564,000,000	130,000,000
1892-93	1,942,000,000	162,000,000
1891-92	2,153,000,000	179,000,000

DOMESTIC AND EXPORT CONSUMPTION OF LARD.

The following table shows the estimated domestic and export consumption of lard from 1892–93 to 1902–03:

Domestic and export consumption of lard, 1892–93 to 1902–03.

[Cincinnati Price Current.]

Year.	Domestic.	Export.	Total.	Year.	Domestic.	Export.	Total.
	Tierces.	*Tierces.*	*Tierces.*		*Tierces.*	*Tierces.*	*Tierces.*
1902-03	795,000	1,594,000	2,389,000	1896-97	658,000	1,600,000	2,258,000
1901-02	1,077,000	1,700,000	2,777,000	1895-96	390,000	1,503,000	1,893,000
1900-01	1,091,000	1,857,000	2,948,000	1894-95	496,000	1,470,000	1,966,000
1899-00	870,000	2,067,000	2,937,000	1893-94	495,000	1,130,000	1,625,000
1898-99	673,000	2,230,000	2,903,000	1892-93	423,000	1,306,000	1,729,000
1897-98	768,000	1,990,000	2,758,000				

COMPARATIVE MONTHLY AND YEARLY PRICES OF HOGS.

Highest monthly and yearly prices of hogs at Chicago per 100 pounds from 1881 to 1902.

[Cincinnati Price Current.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1902	$6.85	$6.55	$7.00	$7.50	$7.50	$7.65	$8.25	$7.65	$8.20	$7.92	$6.95	$6.90	$8.25
1901	5.47	5.65	6.20	6.25	6.00	6.30	6.40	6.70	7.40	7.10	6.30	6.70	7.40
1900	4.92	5.10	5.55	5.85	5.57	5.42	5.55	5.57	5.70	5.55	5.12	5.10	5.85
1899	4.05	4.05	4.00	4.15	4.65	4.00	4.70	5.00	4.90	4.90	4.35	4.45	5.00
1898	4.00	4.27	4.17	4.15	4.80	4.50	4.17	4.20	4.15	4.00	3.85	3.75	4.80
1897	3.60	3.75	4.25	4.25	4.05	3.65	4.00	4.55	4.65	4.40	3.80	3.60	4.65
1896	4.45	4.35	4.25	4.15	3.75	3.60	3.70	3.70	3.50	3.65	3.70	3.60	4.45
1895	4.80	4.65	5.30	5.42	4.97	5.10	5.70	5.40	4.65	4.50	3.85	3.75	5.70
1894	5.65	5.50	5.25	5.60	5.35	5.20	6.00	6.15	6.75	6.15	5.05	4.90	6.75
1893	8.40	8.75	8.55	7.90	8.00	7.45	6.45	6.30	7.05	7.00	6.50	6.60	8.75
1892	4.75	5.05	5.10	5.00	5.10	5.75	6.10	6.20	5.70	5.97	6.07	7.00	7.00
1891	3.85	3.80	5.15	5.50	5.15	4.85	5.85	5.90	5.75	5.50	4.40	4.15	5.90
1890	4.00	4.15	4.45	4.50	4.35	4.05	4.05	4.40	4.95	4.80	4.35	3.90	4.95
1889	5.35	5.05	5.10	5.05	4.85	4.65	4.80	4.80	4.85	4.85	4.25	3.85	5.35
1888	6.00	5.80	5.95	5.90	5.90	5.90	6.75	6.75	6.90	6.90	6.80	5.50	6.90
1887	5.15	5.95	6.10	5.95	5.55	5.35	5.75	5.55	5.60	4.90	5.50	5.90	6.10
1886	4.40	4.65	4.65	4.55	4.40	4.70	5.25	5.25	5.20	4.80	4.20	5.00	5.25
1885	5.05	5.35	5.05	4.85	4.55	4.35	5.30	5.35	4.80	4.35	4.00	4.10	5.35
1884	6.75	7.75	7.60	7.10	6.20	5.90	5.85	6.90	6.90	5.90	5.05	4.60	7.75
1883	7.10	7.65	8.10	8.15	7.90	7.25	6.60	6.50	6.00	5.40	5.50	6.15	8.15
1882	7.35	7.50	7.65	7.80	8.60	8.75	9.00	9.50	9.30	9.25	7.75	7.00	9.50
1881	5.90	6.75	6.75	6.65	6.60	6.35	7.10	7.00	7.50	7.40	6.90	6.65	7.50

PRICES OF HOG PRODUCTS.

Prices of mess pork, D. S. short-rib sides, S. P. hams, and S. P. shoulders at Chicago, March 1, 1881, to 1903.

[Cincinnati Price Current.]

Year.	Mess pork.	Lard.	S. R. sides.	Hams.	Shoulders.
	Per barrel.	*100 pounds.*	*100 pounds.*	*100 pounds.*	*100 pounds.*
1903	$18.25	$9.70	$9.75	$10.80	$8.55
1902	13.25	8.95	8.25	9.40	7.00
1901	13.90	7.35	7.00	8.75	6.50
1900	10.50	5.75	5.75	9.25	6.50
1899	9.25	5.25	4.65	7.00	4.50
1898	10.35	5.10	5.00	7.15	5.00
1897	8.00	4.00	4.20	8.50	4.75
1896	9.75	5.35	5.05	8.00	5.25
1895	10.20	6.40	5.15	8.25	5.15
1894	11.85	7.05	6.10	9.00	6.90
1893	18.25	12.70	10.20	13.50	10.00
1892	11.15	6.42½	5.82½	8.40	5.00
1891	9.65	5.65	4.67½	6.85	3.45
1890	9.80	5.85	4.80	8.40	4.50
1889	11.15	6.70	5.90	9.00	5.50
1888	13.90	7.70	7.15	9.50	6.12½
1887	18.25	7.05	7.65	11.00	7.00
1886	10.45	5.85	5.30	8.00	4.37½
1885	12.40	6.80	6.10	8.62½	5.37½
1884	17.80	9.40	9.25	12.25	7.75
1883	18.20	11.42½	9.85	11.00	8.00
1882	17.00	10.40	9.00	10.25	6.75
1881	14.37½	10.00	7.32½	8.50	5.50

For 1887 the price of mess pork on March 1 was influenced fully $3.50 per barrel by manipulation.

CHICAGO PORK AND LARD PRICES.

Lowest, highest, and average yearly prices at Chicago for mess pork per barrel and lard per hundred pounds, 1870 to 1902.

[Cincinnati Price Current.]

Year.	Pork.			Lard.		
	Low.	High.	Average.	Low.	High.	Average.
1870	$18.00	$30.50	$26.25	$11.00	$17.25	$15.00
1871	12.00	23.00	15.90	8.37	13.00	10.25
1872	11.05	16.00	13.10	7.00	11.00	8.50
1873	11.00	18.00	14.80	6.50	9.37	7.90
1874	13.75	24.75	18.35	8.20	15.50	11.50
1875	17.70	23.50	20.20	11.80	15.75	13.50
1876	15.20	22.75	18.65	9.55	13.85	11.25
1877	11.40	17.95	14.05	7.55	11.55	9.10
1878	6.05	11.45	8.80	5.32	7.80	6.67
1879	7.30	13.75	9.85	5.32	7.85	6.22
1880	9.40	19.00	13.15	6.35	8.75	7.37
1881	12.50	20.00	16.55	8.37	13.00	10.90
1882	16.00	24.75	19.30	10.05	13.10	11.45
1883	10.20	20.15	15.30	7.15	12.10	9.65
1884	10.55	19.50	16.05	6.45	10.00	7.05
1885	8.00	13.25	10.40	5.82	7.10	6.47
1886	8.20	12.85	9.80	5.82	7.50	6.22
1887	11.60	24.00	15.95	6.20	7.92	6.75
1888	12.90	16.00	14.10	7.25	11.20	8.42
1889	8.35	13.87	11.00	5.75	7.55	6.50
1890	7.50	13.62	10.60	5.50	6.52	6.00
1891	7.45	13.00	10.25	5.47	7.05	6.25
1892	9.35	15.05	11.35	6.05	10.60	6.95
1893	10.25	21.80	17.30	6.37	13.20	9.85
1894	10.67	14.57	12.50	6.45	9.05	7.35
1895	7.50	12.87	10.25	5.15	7.17	6.25
1896	5.60	10.85	7.50	3.05	5.85	4.35
1897	7.15	9.00	8.00	3.42	4.90	4.15
1898	7.65	12.30	9.45	4.62	6.82	5.25
1899	7.85	10.45	8.70	4.90	5.77	5.25
1900	10.35	16.00	11.70	5.65	7.40	6.65
1901	12.60	16.80	14.60	6.90	10.25	8.60
1902	15.00	18.70	16.25	9.07	11.60	10.25

RELATIVE COST OF HOG PRODUCTS.

The following figures and comments by the Cincinnati Price Current form an interesting and instructive study of the relation between the cost of hogs on the hoof and the dressed product:

It is impracticable to compile a table indicating the relative value of leading articles of hog products on the basis of cost of hogs which would be a permanent guide in these particulars, owing to the changes frequently occurring in the relation of these values, as well as some variation in the proportions of product made. On March 1, 1903, Chicago prices were about $9.60 per 100 pounds for green sides, $8.30 for green shoulders, $10.65 for green hams, and $9.70 for lard in tierces. On this basis, calculating sides at 36 per cent, shoulders 10 per cent, hams 11 per cent, and lard 14 per cent of live weight of hogs, and that the remainder of the product, or offal, covers the cost of manufacture, these values represent $6.76 per 100 pounds for hogs alive, and relatively for the various prices stated for hogs, as shown in the following compilation, * * * indicating cost of green sides, shoulders, and hams, lard in tierces per 100 pounds, and mess pork per barrel:

Relation between prices per 100 pounds of live hogs and of the dressed products.

Hogs, alive.	Sides, green.	Shoulders, green.	Hams, green.	Lard, in tierces.	Pork, in barrels.
$3.00	$4.25	$3.68	$4.72	$4.48	$8.74
3.25	4.60	3.99	5.11	4.83	9.39
3.50	4.96	4.30	5.50	5.38	10.04
3.75	5.31	4.61	5.89	5.53	10.69
4.00	5.67	4.91	6.29	5.88	11.34
4.25	6.02	5.22	6.68	6.23	11.99
4.50	6.38	5.52	7.08	6.57	12.64
4.75	6.73	5.83	7.47	6.92	18.29
5.00	7.09	6.13	7.87	7.26	13.93
5.25	7.44	6.44	7.26	7.61	14.58
5.50	7.80	6.75	7.65	7.95	15.23
5.75	8.15	7.06	8.04	8.30	15.88
6.00	8.51	7.36	9.44	8.64	16.52
6.25	8.86	7.67	9.83	8.99	17.17
6.50	9.22	7.98	10.22	9.33	17.82
6.75	9.57	8.29	10.61	9.78	18.47
7.00	9.93	8.59	11.01	10.02	19.11
7.25	10.28	8.90	11.40	10.37	19.76
7.50	10.64	9.21	11.80	10.72	20.41
7.75	10.99	9.51	12.19	11.06	21.06
8.00	11.35	9.82	12.59	11.41	21.70
8.25	11.70	10.13	12.98	11.75	22.35
8.50	12.05	10.44	13.37	12.10	23.00

In order to indicate the relative value of hogs at a stated price for mess pork and green sides, on the basis of values in Chicago on March 1, 1903, as mentioned, the following is submitted:

Relative value per 100 pounds of dressed product and live hogs.

Pork.	Hogs.	Pork.	Hogs.	Pork.	Hogs.
$7.00	$2.32	$11.50	$4.05	$16.00	$5.80
7.50	2.51	12.00	4.25	16.50	5.79
8.00	2.70	12.50	4.44	17.00	6.18
8.50	2.89	13.00	4.64	17.50	6.37
9.00	3.09	13.50	4.83	18.00	6.57
9.50	3.28	14.00	5.02	18.50	6.76
10.00	8.48	14.50	5.21	19.00	6.96
10.50	8.67	15.00	5.41	19.50	7.15
11.00	8.86	15.50	5.60	20.00	7.34
Sides.	**Hogs.**	**Sides.**	**Hogs.**	**Sides.**	**Hogs.**
$3.50	$2.47	$5.75	$4.05	$8.00	$5.64
8.75	2.65	6.00	4.23	8.25	5.82
4.00	2.82	6.25	4.40	8.50	6.00
4.25	3.00	6.50	4.58	8.75	6.17
4.50	8.17	6.75	4.75	9.00	6.34
4.75	3.35	7.00	4.93	9.25	6.51
5.00	3.52	7.25	5.10	9.50	6.69
5.25	8.70	7.50	5.28	9.75	6.87
5.50	3.87	7.75	5.46	10.00	7.05

To illustrate the changes through variation in relative values of different articles of product, the following is presented as showing figures for the dates mentioned, on the basis of $5 for hogs:

Value of hog products with live hogs at $5 per 100 pounds, 1889 to 1902.

[Cincinnati Price Current.]

March 1—	Green sides.	Shoulders.	Hams.	Lard.	Pork.
1889	$6.60	$5.60	$9.47	$7.62	$13.85
1890	6.25	5.35	10.74	7.73	12.06
1891	6.51	5.00	9.87	8.00	13.14
1892	6.61	5.81	9.47	7.42	13.26
1893	6.48	6.15	8.42	8.33	12.91
1894	6.52	6.08	9.24	7.63	12.89
1895	6.89	5.75	9.50	8.01	12.64
1896	6.54	6.07	10.04	6.97	12.63
1897	6.21	6.44	12.12	5.91	12.33
1898	6.74	6.40	9.26	6.78	13.19
1899	6.56	5.83	9.48	7.53	12.96
1900	6.50	6.79	10.18	6.44	12.85
1901	6.83	6.23	8.48	7.33	13.46
1902	6.94	5.83	7.98	7.72	13.65

PORK PACKING IN CANADA.

Prior to two years ago pork-packing operations in Canada had steadily increased for a number of years. During the past two years there has been a decline in this industry in the Dominion.

Official returns of the number of hogs reported on farms on July 1 are published yearly by the Province of Ontario, which furnishes the largest proportion of supplies. The following are yearly comparisons for Ontario:

Hogs in Ontario.

[Cincinnati Price Current.]

Year.	Over 1 year.	Under 1 year.	Total.
1893	220,396	791,626	1,012,022
1894	227,878	914,255	1,142,133
1895	244,185	1,054,887	1,299,072
1896	243,756	1,025,875	1,269,631
1897	235,479	1,049,484	1,284,963
1898	267,048	1,375,739	1,642,787
1899	295,349	1,675,721	1,971,070
1900	265,457	1,506,184	1,771,641
1901	222,916	1,268,969	1,491,885
1902	238,992	1,445,643	1,684,635

The number of hogs sold or slaughtered in Ontario for years ending June 30 are officially stated as follows:

Hogs killed in Ontario.

[Cincinnati Price Current.]

	Number.
1897	1,399,967
1898	1,592,679
1899	1,875,466
1900	2,056,049
1901	1,973,405
1902	1,991,907

Information obtained by the Cincinnati Price Current indicates the following as the number of hogs packed in Canada for the eight summer-season months (March 1 to November 1), the four winter months (November 1 to March 1), and total for the year ending March 1, 1875–76 to 1901–02:

Hogs packed in Canada.

[Cincinnati Price Current.]

Year.	Summer.	Winter.	Twelve months.
	Number.	*Number.*	*Number.*
1902–03	600,000	400,000	1,000,000
1901–02	580,000	390,000	970,000
1900–01	710,000	450,000	1,160,000
1899–00	877,042	614,001	1,491,043
1898–99	725,000	500,000	1,225,000
1897–98	500,000	400,000	900,000
1896–97	450,000	350,000	800,000
1895–96	400,000	350,000	750,000
1894–95	209,010	301,640	510,650
1893–94	142,550	279,920	422,470
1892–93	128,611	227,409	356,020
1891–92	99,466	251,088	350,554
1890–91	91,910	234,970	326,880
1889–90	69,436	169,273	238,709
1888–89	35,343	143,137	178,480
1887–88	70,540	145,674	216,214
1886–87	84,811	171,474	256,285
1885–86	65,230	126.660	191,890
1884–85	55,573	154,575	210,148
1883–84	37,684	99,944	137,628
1882–83	28,715	140,814	169,529
1881–82	57,016	129,971	186,987
1880–81	37,857	156,763	194,620
1879–80	37,447	157,932	195,379
1878–79	8,579	115,775	124,354
1877–78	12,957	151,781	164,738
1876–77	58,544	186,198	244,742
1875–76	25,000	119,989	144,989

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U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF ANIMAL INDUSTRY—Bulletin No. 48.

D. E. SALMON, D. V. M., Chief of Bureau.

THE

ANIMAL INDUSTRY OF ARGENTINA.

BY

FRANK W. BICKNELL,

Special Agent and Agricultural Explorer.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., July 8, 1903.

Sir: I have the honor to transmit herewith the manuscript of a paper entitled "The Animal Industry of Argentina," by Frank W. Bicknell, special agent and agricultural explorer.

Mr. Bicknell shows the status of the animal industry of Argentina at this time, and dwells upon the prospects of that Republic as a market for purebred animals from the United States. Some excellent photographs of the cattle, sheep, and horses now being produced in that country accompany the paper.

The subject-matter of this paper is such as will go far toward answering the many requests that come to the Department of Agriculture for information regarding the animal industry of Argentina, and I recommend that it be published as a bulletin of the Bureau of Animal Industry series.

Respectfully,

D. E. Salmon, *Chief of Bureau.*

Hon. James Wilson, *Secretary.*

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ARGENTINE TERMS AND MEASURES USED.

Money.—Unless otherwise stated, all expressions of value used herein refer to Argentine paper money, which will cost the foreigner to-day (May, 1903) 44 cents of United States money for the peso (dollar). The valuations in the custom-house, in which the amounts of imports and exports are stated, are in Argentine gold, worth 96.5 United States money for the peso.

Metric ton; used in the customs statistics.—2,204.62 pounds.

Kilo.—2.2046 pounds.

Liter.—1.0567 quarts, or 0.264 gallon.

Hectoliter.—2.837 bushels, dry measure, or 26.417 gallons, liquid measure.

Hectare of land.—2.47 acres.

Square of land.—4.17 acres.

League of land.—6,672 acres.

Meter.—39.37 inches.

Kilometer.—0.621 mile.

Estancia.—A stock farm, generally very large, where breeding steers and wethers for market, and sometimes also breeding purebred animals for sale as breeding animals, are carried on.

Estanciero.—The man who owns an estancia.

Cabaña.—An establishment where breeding animals are raised for sale.

Cabañero.—The man who owns a cabaña.

Camp.—The term generally applied to the country, the rural part, derived, no doubt, from the Spanish word "campo," meaning the country. People in town say "I am going to the camp," instead of saying "I am going to the country."

Inside camp.—The better and more cultivated and favorably situated land and pastures; usually applied to the better portions of the province of Buenos Aires.

Outside camp.—The more distant, less fertile, dryer and less valuable part of the grazing country.

Mestizo.—Graded animals—partly pure-blooded, of any sort.

Novillos.—Steers.

Embarcadero.—The yards and sheds in the port of Buenos Aires where imported animals are received and where export animals are inspected and dispatched on board ship.

Frigorifico.—Frozen-meat establishment.

Lecheria.—Either a milk depot in the city for the sale of milk at retail or the establishment of a milk dealer in the country.

Puchero.—The national dish, especially for the poorer classes. It consists generally of beef, potatoes, and whatever other vegetables may be had. It is all boiled together in one dish and is served in the same manner, requiring few dishes. Some kind of squash is a favorite addition and sometimes chicken is added or substituted for beef. Occasionally a little pork is put in. If good meat is used and it is well cooked and not too much water used, it is very palatable and nourishing. The better families make it with chicken, well flavored, and the chicken and vegetables are served separately.

Chacarero.—A farmer—a man who tills the land and raises a crop on a chacra, or farm.

THE ANIMAL INDUSTRY OF ARGENTINA.

By Frank W. Bicknell,
Special Agent and Agricultural Explorer.

INTRODUCTION.

The Argentine Republic is not to be studied hastily if reliable information is expected. Many mistaken ideas of the country have been promulgated by those who have spoken or written from imperfect knowledge or from hasty surface observations. It is difficult to obtain complete or accurate information regarding any resource or industry. Neither Government officials nor the people engaged in any kind of business have collected and published complete and exact reports concerning what is being done or may be done in the country. One can never be sure to what extent statistics have been "estimated," and the operation of comparing and analyzing a part of these reports is likely to reveal flaws that raise doubts as to the reliability of the whole. So the independent investigator, desiring to prove all things—to take nothing for granted and to state nothing of which he is himself in doubt—must get as many facts, estimates, and opinions as possible, and then, adding his own observations and knowledge, be prepared to judge of the value of what he has heard and read and to form his own conclusions. This is the policy which was adopted by the writer in his investigations in Argentina during parts of the years 1902 and 1903—something over a year altogether. This brief account of some phases of the live-stock industry in the great, rich Republic of the south is conservative rather than enthusiastic, and the statements made herein have been carefully verified.

The first object of this inquiry was to determine whether or not the breeders of pure-blooded stock in the United States could sell animals in Argentina. That question may be answered positively in the affirmative, providing the conditions here set forth are studied and observed and only first-class animals are sent to the Argentine sales. If some good Shorthorn bulls and cows could arrive in Buenos Aires from about the 1st to the 20th of August, so they could pass the required forty days in quarantine and be ready to be shown at the time of the great annual stock show and sales in the latter part of

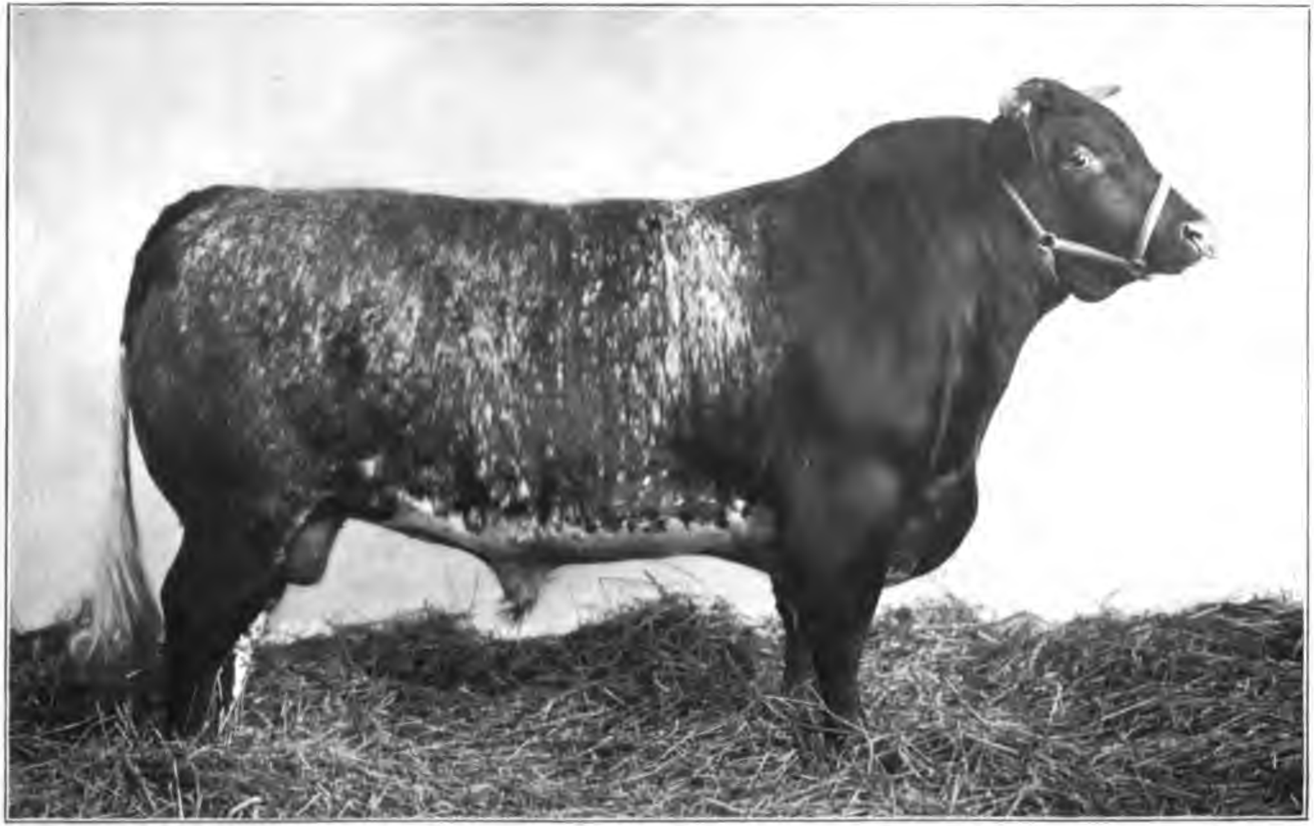
September and the first of October, there is little doubt that the returns would be quite satisfactory to those who sent them.

Because this country is a long distance from the United States and the people strange to us, we should not be frightened and hesitate to reach out for a business that is so simple and that has earned such handsome profits for others. There is nothing to fear in taking stock to Argentina to sell if the animals are right. They should without fail be tested for tuberculosis before leaving home, for they will be subjected to the tuberculin test there at the end of the forty days' quarantine, and, if they react, showing that they have the disease, they will have to be slaughtered or removed from the country immediately. The English breeders who send animals to Argentina do not generally do this. Our Government certificate showing freedom from tuberculosis would therefore add to the value of the animals.

There is no prejudice against any North American in Argentina that is worth taking into consideration in any business enterprise. Any man from the United States who has something to sell that pleases the people there will be well received, and he has as good a chance to sell it as any other man from any other country, providing that he knows the conditions as well as the other man and conforms to them. These things he must learn. To sell breeding stock he will have no trouble if the animals are the right sort, for good breeding stock is keenly sought after, and the supply is inadequate. The Argentines would be very glad to see us enter more into competition with the English and others in respect of their trade, and we may do so very profitably and safely if we study the conditions and observe them in what we do. The writer met with a very cordial reception among Argentines, and has to acknowledge many courtesies. He found them, as well as the English farmers and stock raisers, who are very strong there, always willing to give information. They show a lively interest in us and admiration for our development.

THE ARGENTINE RURAL SOCIETY.

The first Argentine Rural Society (Sociedad Rural Argentino), the progenitor of the present organization bearing that name, had its origin in 1857. The prime mover in putting the idea into effect has told the writer the story of the inception and development of this, probably the most important, organization in Argentina. Like many other good things in Argentina, it had its inception in England. Don Eduardo Olivera, then a student in London, attending the lectures of John Nesbit on agricultural chemistry, noticed in a Buenos Aires newspaper an article by Domingo Faustino Sarmiento, afterwards President of the Republic and also the man who introduced the North American teachers to Argentina, commending a letter the young



LORD WENLOCK, FIRST-PRIZE 3½-YEAR-OLD SHORTHORN BULL. SOLD FOR $6,000.

LADAS 6TH, FIRST-PRIZE 2½-YEAR-OLD SHORTHORN BULL, AND CHAMPION OF SHORTHORNS. SOLD FOR $10,300.

man had written to his father describing the agricultural show in Birmingham. The Argentines were advised to avail themselves of the benefits of like organizations, and this led to the organization the following year of the first agricultural show in the country—a very small affair, under the presidency of Gervasio A. Posadas. During the show a meeting of estancieros[a] was held and a committee named to form a rural society. This committee consisted of Señores Posadas, Sarmiento, Olivera, Favier, and Clark. But civil war came on, and the committee never met. It was not until July, 1866, that fourteen breeders met in Buenos Aires and organized the present Rural Society. The provisional committee was José Martinez de Hoz, Eduardo Olivera, and Ramon Viton. The rules and plan for the society, which had been prepared in 1858 by Señor Olivera, were the basis of the permanent organization, which was perfected a month later (August, 1866) with forty-seven members. The chief objects of the society, as then set forth, were the following:

(1) To promote by all possible means the improvement of our stock in a rational way, based upon scientific experience.

(2) To study the best means of irrigating our dry camps, as well as to drain swamps.

(3) To promote the morality and well-being of our camp population.

(4) To study the best breeds of cattle and sheep abroad, with the purpose of improving, by importation of breeding animals, the stock we now possess.

(5) To search for and study scientific methods adapted to the conditions of our country and calculated to increase our agricultural output.

(6) To secure commercial relations with foreign countries, in order to exchange produce and create a market for ours abroad.

To assist in carrying out these purposes, it was deemed necessary to secure rational teaching of agriculture and to establish an agricultural museum to display national products, soils, etc., and also foreign produce of a similar nature, to serve as models. Practical tests of the most improved machinery were provided for. The museum was founded under the presidency of Señor Olivera, and later has been reorganized as the Industrial Club, its scope greatly enlarged, and made a very important factor in the industrial development of the country, maintaining, as it does, a permanent exposition of national products in Buenos Aires.

The first pretentious show of the Rural Society was held in Palermo, a suburb of Buenos Aires, in 1875. The officers and their friends—those personally engaged in the venture—had great difficulty in getting any animals to exhibit. Very few seemed to take much interest in the show. Only 18 cattle, 19 sheep, and 19 horses were exhibited. In fact, it was not until 1895 that the show assumed national and noteworthy importance. Its development since then has been rapid, steady, and sure, except as regards sheep, with which there have been fluctuations. The following comparison of the number of animals exhibited since 1895 shows the development of the exposition:

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[a] See page 5 for explanation of this and other terms.

Number of cattle, horses, and sheep, and value of sales at the expositions of the Rural Society, 1895 to 1902.

Year.	Cattle.	Horses.	Sheep.	Sales.
1895	253	84	531	$130,000
1896	497	91	1,783	300,000
1897	654	116	2,080	335,000
1898	942	245	1,157	660,000
1899	1,487	191	2,204	880,000
1900	1,736	271	2,068	975,000
1901	1,881	249	1,800	916,000
1902	2,068	314	1,718	1,291,797

Besides these, other sales are held every year, at various other fairs in other parts of the country, usually in August, September, and October. Last year an exposition similar to the one in Buenos Aires was held in Rosario, and, for the first effort, was remarkably successful. The sales were small, because at that time the crop outlook was very uncertain; pastures had suffered from frost and drought in the country tributary to that show, and estancieros were avoiding every possible expenditure. The rains came and the prospect brightened very much, however, before the Palermo show in Buenos Aires was held; so the sales there were good.

Various fairs are held in the province of Buenos Aires, some of them under the auspices of societies and some by auctioneers for the sale of live stock—both breeding stock and stock cattle, fattened or to be fattened, and sheep. Then, there are the sales held in the auction houses in Buenos Aires, which are very important to breeders, for here are brought together representatives of the best herds and flocks in the country and also the best imported animals. This year all the imported animals, which are already arriving from England, will be sold in these great auction marts.

The next show, to be held in September and October, 1903, will be a national show, where only those animals bred in the country will be admitted, either for exhibition or sale, unless owned by Argentines at the present time (May, 1903). All imported stock will therefore be sold in the auction marts in the city. Next year (1904) the show will probably be international, foreign-bred animals being admitted. Both before and after the show, every year, sales are in progress in these marts. Two of them are a block in depth, opening on two streets in the business center and have large, airy, clean stalls and auction rings, where the animals are well cared for and shown to the best advantage. Sales of rams are held here at the time of the September-October show, and again in January, and then, beginning in March, for several weeks. In January of this year 383 rams were sold in one sale. The September-October sales are always best, however. Nearly all kinds of live stock are sold at auction in this country.

Until the organization of the national department of agriculture, about four years ago, the Rural Society exerted a tremendous influence upon legislation and all regulations affecting the stock and agricultural interests, especially the former. It is composed mostly of wealthy and influential men, most of whom live at least a large part of the year in the city of Buenos Aires. They are owners of hundreds of thousands of acres of the best land in the Republic and are chiefly interested in stock raising. The influence of the Rural Society is still very great, and it is extending its usefulness by trying to interest and benefit the agricultural class, even the small colonist. The first agricultural show proper was held in May of this year, and it was the aim of the management to make it similar to our great agricultural fairs. For a number of years the society has held a show at this time for the exhibition of fat stock and horses only.

The Rural Society affiliates to a certain extent with similar organizations in other provinces, and a delegate is appointed to represent the Rural Society in each of these. There are eight of these provincial societies, most of which publish monthly bulletins, and several local or district societies in the province of Buenos Aires that hold local fairs and sales.

They are beginning to learn in Argentina what their big fertile country can do for them, and where and how to make the best of it. They lack agricultural literature and periodicals, such as we have, because the scientific study of agriculture is only just beginning, and because the farmers (called chacareros, as distinguished from estancieros, or stock raisers), the men who are raising crops, are mostly foreigners, many of them unable and unwilling to read. Of course, there are many proprietors (owners of land on a large scale) and a few small farmers who are eager for the best information to be had. For the benefit of these the Rural Society publishes a monthly review, or bulletin, of 60 to 100 pages, containing the best information obtainable regarding agricultural and stock-raising matters, with market conditions the world over, and such statistical information as may be had. The Rural Society in Rosario also publishes a monthly bulletin, and so do some of the other rural societies. The ministry of agriculture publishes, besides numerous special bulletins and reports, a semimonthly bulletin covering the whole field of agriculture, stock raising, forestry, etc., which is quite exhaustive. The newspapers give considerable attention to live stock and agriculture. One English daily has a page on Sunday given wholly to these subjects. The English estancieros have done much for the country by adopting improved methods, and they are all students of agricultural and live-stock literature. Periodicals and books, and especially the publications of the United States Department of Agriculture, are eagerly seized upon by the energetic, progressive English, and by many native Argentines of Latin blood who have learned English and desire to profit by our experience and study.

THE GREAT ANNUAL STOCK SHOW.

All Argentine breeders, or at least 95 per cent of them, look forward to the annual show of breeding stock, given by the Argentine Rural Society in September and October in Buenos Aires, as the time when they will sell the animals they have raised for other breeders or for estancieros and secure new blood for their herds. The show is a great national stock exchange, where the breeders bring what they have to offer and come to see what others have done, and the estancieros, the producers of beef and mutton and wool and horses, come to buy "reproductores" to supply their large needs; so there are buyers for all classes of animals. The cabañero, or breeder of pedigreed animals, looks only for the best, and is willing to pay fancy and practically unlimited prices for animals that meet his ideas of perfection. The estanciero, or producer of beef, mutton, and wool, looks only, as a rule, for animals of individual merit for his own use in the camp, and he does not care for pedigree. He is contented with a grade bull that he can buy at $200 to $1,000. The same is true of the sheep and horses shown in the exposition, as it will be noticed that many well-bred mestizos, or graded animals, sold for good prices in cattle and sheep and poor prices in horses.

The opening of the fair is a gala occasion. The President of the Republic always attends and the minister of agriculture delivers an address, as well as the president of the society. The speech of the latter, made at the opening of the exposition in September, 1902, contained some rather remarkable suggestions, as he is a firm friend of England, and has been much gratified by having been made an honorary member of the Royal Agricultural Society of Great Britain. This gentleman, Dr. E. Ramos Mexia, was formerly minister of agriculture and a member of the Argentine Congress, where he advocated the passage of a law requiring the modification of the tuberculin test of cattle for tuberculosis, in that animals not far advanced in the disease should not be slaughtered on arrival in the country, but should be branded so they could be known and kept apart from others. But this proposition was defeated and the disposition of animals found to be affected with tuberculosis under the tuberculin test was left, in the order putting the law into effect, to the determination of the executive. This decree orders the destruction of the animals or their immediate shipment out of the country. Dr. Ramos Mexia has published a pamphlet on the subject in the English language, in which he gives his speeches in Congress sustaining his contentions. The work is dedicated to the Royal Agricultural Society of England.

After the first week of the fair much of the best stock is removed. The attendance is not large at any time—only a few hundred men being present, except on a few afternoons, when the ladies come. The show has been and is yet, to a large extent, for rich men—those doing business on a large scale. The small farmers and stock raisers do not come to see it. It is in no sense a fair like our great State fairs. This year they are organizing for the first time an agricultural fair, to be combined with the fat-stock show this month (May, 1903), in which they hope to interest a greater number of small proprietors. The admission fee at the exposition is at first $2 and is gradually reduced to 50 cents during the second week.

The visitor, fresh from the United States, with indefinite ideas about "the wild cattle on the pampas of the Argentine Republic" is astonished to land here, pass through this great, modern, healthy city of 876,000 people, past its beautiful, well-kept parks to the well-equipped and admirably arranged grounds of the Argentine Rural Society, and there find the greatest collection of purebred cattle and sheep that he ever saw. The grounds are beautiful, and the buildings and stalls for animals are very well arranged and spacious. The location is in a suburb of the city called Palermo, near the finest park in the city.

The new feature of this year's show was the dairy exhibit, the first one the society has given. This was demanded by the lively interest in that industry now being manifested in the country, and this exhibit attracted more attention from the people than any other part of the show. A very large building was supplied with power, and all sorts of dairy machinery was shown in operation. The United States was not well represented in this exhibit, but our manufacturers might do well there.

Very little interest is taken in hogs in Argentina, as their absence from the exposition shows. It is quite safe to predict that some day pork will be one of the chief sources of Argentine wealth, but at present the business of hog raising is out of favor, though the products of the hog, when properly prepared, bring high prices. The chief obstacle seems to be the lack of a reliable market at this time for a large production, and the high taxes and great amount of inspection that accompany the marketing of pork. Argentina once had a good market in Brazil, but that was lost by the degeneration of the pork owing to the feeding of pigs on decayed animals and other offal. When the system of feeding corn to animals is adopted, and large packing houses assure producers of a steady market, the hog business will come up in Argentina, for there appears to be no good reason why it should not.

The work of the judges in this exposition is generally done before the show opens. This is always the practice in the fat-stock show in May.

THE ANNUAL SALES OF BREEDING STOCK.

The most significant feature of the stock show in September was the sale of the animals brought there for that purpose; for that, undoubtedly, is the vital thing in the whole enterprise—that which gives it such an attraction for breeders and meat producers. Not an imported animal was sold in the show, and only a few just before. These few were an installment that had been brought from the United States about two years before, and, having left New York the day after the Argentine ports were closed to the United States, were prohibited from entering the country until this time. They were chiefly of Scotch blood and most of them had been imported into the United States and Canada. The highest price got by any of them was $7,400 for a roan 3½ years old. Others sold for $4,900, $4,500, $3,500, $4,450, and so on. One bull, a Cruikshank 4½ years old, was from Danvers, Ill. His age was against him, as it was with all this lot, and he had a bad knee. He has not been sold and is on an estancia owned by the importer. There is no profit in bringing bulls here over 30 months old, and 24 months or thereabouts is better.

In this show in September and October 1,402 cattle, 199 horses, and 924 sheep were sold. The numbers of each exhibited were: Cattle, 2,068; horses, 314, and sheep, 1,718. Six pigs and 31 representatives of the poultry yard were sold, the pigs averaging about $45 each and the poultry $11.

The prices for breeding cattle were generally better than ever before, owing to the lack of any imported stock and to the prosperous outlook for the stock interests and for the country generally. The prices obtained for ordinary camp bulls—not eligible to registration in the herdbook, from grade cows wholly without pedigree—were the most astonishing. These were shown in open pens in lots of from 4 to 10 animals, generally about 8. Of the Shorthorns there were 74 lots, comprising 542 animals, that sold for $214,514, or an average of $395.78. This is equivalent to about $174 United States money. Twelve of these animals sold for more than $1,000 each, the highest being $1,500. Many brought from $600 to $950, and the lowest price was $70, and this for only a few animals. The Shorthorn heifers of the same class did not sell so well, for they were inferior animals. Somewhat over 300 of them were shown, of which 157 were sold at an average of $216.65, the highest being $850 and the lowest $40. These heifers were not considered good animals, or they would have brought good prices. The best heifers are rarely offered at public sale. Comparatively few breeders have cows or heifers to sell, or at least they do not offer the best of these as they do with their bulls. They keep the heifers for their own use as a rule and sell only the least desirable animals. Breeders are keenly on the lookout for good cows and heifers, and if any are for sale some one in the neighborhood is likely to buy them privately, saving the owner the trouble and expense of taking them to market to be sold at auction. These conditions explain the rather indifferent quality, the comparatively low prices, and small numbers of cows and heifers at the annual stock show.

Taking the prize-winning animals as they come, according to age, we may learn something of the preferences of Argentine breeders and the prices they are willing to pay. It should be remembered that these prices for native bulls were higher than ever before because of the fact stated above that there had been no importations of any consequence for eighteen months.

SHORTHORN BULLS.

Born March 1 to December 31, 1899: (1) Lord Wenlock, roan, bred by Pereyra, sold for $6,000; (2) Boer 137, roan, bred by Pereda, sold for $3,200; (3) Baron 049, red and white, bred by Gimenez Paz, sold for $7,200. Twenty-eight entries, 26 sold, average $2,688; highest $7,200, lowest $1,300.

Born January 1 to June 30, 1900: (1) Ladas 6, roan, champion of the show and winner of special prizes, bred by Thomas Bell, sold for $10,300; (2) Surcouf, roan, bred by Fages, sold for $10,500; (3) Somerville 310, roan, bred by Vivot, sold for $7,000; honorable mention, Mercurio 152, roan, bred by Pereda, sold for $11,100. Nineteen entries, 18 sold, average $3,944; highest $11,100, lowest $750.

Born between July 1 and December 31, 1900: (1) Farrier Bridekirk, red, bred by Pereyra, sold for $11,000; (2) Sultan 12, roan, bred by Villafañe, sold for $4,000; (3) Ulpiano, red, bred by Fages, sold for $5,300; first honorable mention, Stanley 325, red and white, bred by Vivot, sold for $4,200; second honorable mention, Boulevard 062, red, bred by Gimenez Paz, sold for $6,000. Sixty-one entries, 51 sold, average $2,795; highest $11,000, lowest $665.

Born between January 1 and June 30, 1901: (1) Newton Stone, roan, bred by Thomas Bell; (2) Alexandro Beauty 091, roan, bred by Gimenez Paz; (3) Fernando, roan, bred by Aldao. Twenty-three entries, but none of the winners sold; 9 others in the class sold from $1,100 to $5,600, average $1,877.

SHORTHORN COWS.

Born before January 1, 1900: (1) Stella 155, red, bred by José Cobo; (2) Duchess Lily 22, red and white, bred by Anchorena; (3) Celestina 103, roan, bred by Malbran, sold for $2,000. Seven entries, 1 sale.

Born between January 1 and June 30, 1900: (1) Duchess Lily 26, roan, bred by Anchorena; only entry.

Born between July 1, 1900, and March 1, 1901: (1) Calomel 16, roan, bred by Pereyra: (2) Dalia 89, roan, bred by Pereyra; (3) Rosemary, red and white, bred by Cardenas, sold for $2,000. Eight entries, 4 sales at $2,000 each.

HEREFORD BULLS.

Born between March 1 and December 31, 1899: (1) Grandison 42, champion of the breed in the show and also champion of the bulls of the beef races, bred by Villafañe, not sold, and since died; (2) Caronbier 54, bred by Pereda, sold for $2,150; (3) Kaki 63, bred by Pereda, sold for $1,100. Four entries, 2 sales.

Born between January 1 and June 30, 1900: (1) Shamrock, bred by Pereyra; (2) Malmesbury 9, bred by Villafañe, sold for $3,200; (3) Grandison 52, bred by Villafañe, sold for $2,000. Four entries, 3 sales; lowest $800.

Born between July 1 and December 31, 1900: (1) Wonderful, bred by Pereyra; (2) Grandison 15, bred by Villafañe; (3) Grandison 55, bred by Villafañe, sold for $2,500. Fourteen entries; 10 sales at $500 to $2,500, average $925.

Born between January 1 and June 30, 1901: (1) Grandison 63, (2) Grandison 65, and (3) Iron King, all bred by Villafañe, and the 3 sold for $7,000.

Only 1 Hereford cow, born between July 1, 1900, and March 1, 1901, was shown for a prize: Zamora, shown by Pereyra, and given a second prize, and not sold.

OTHER BREEDS.

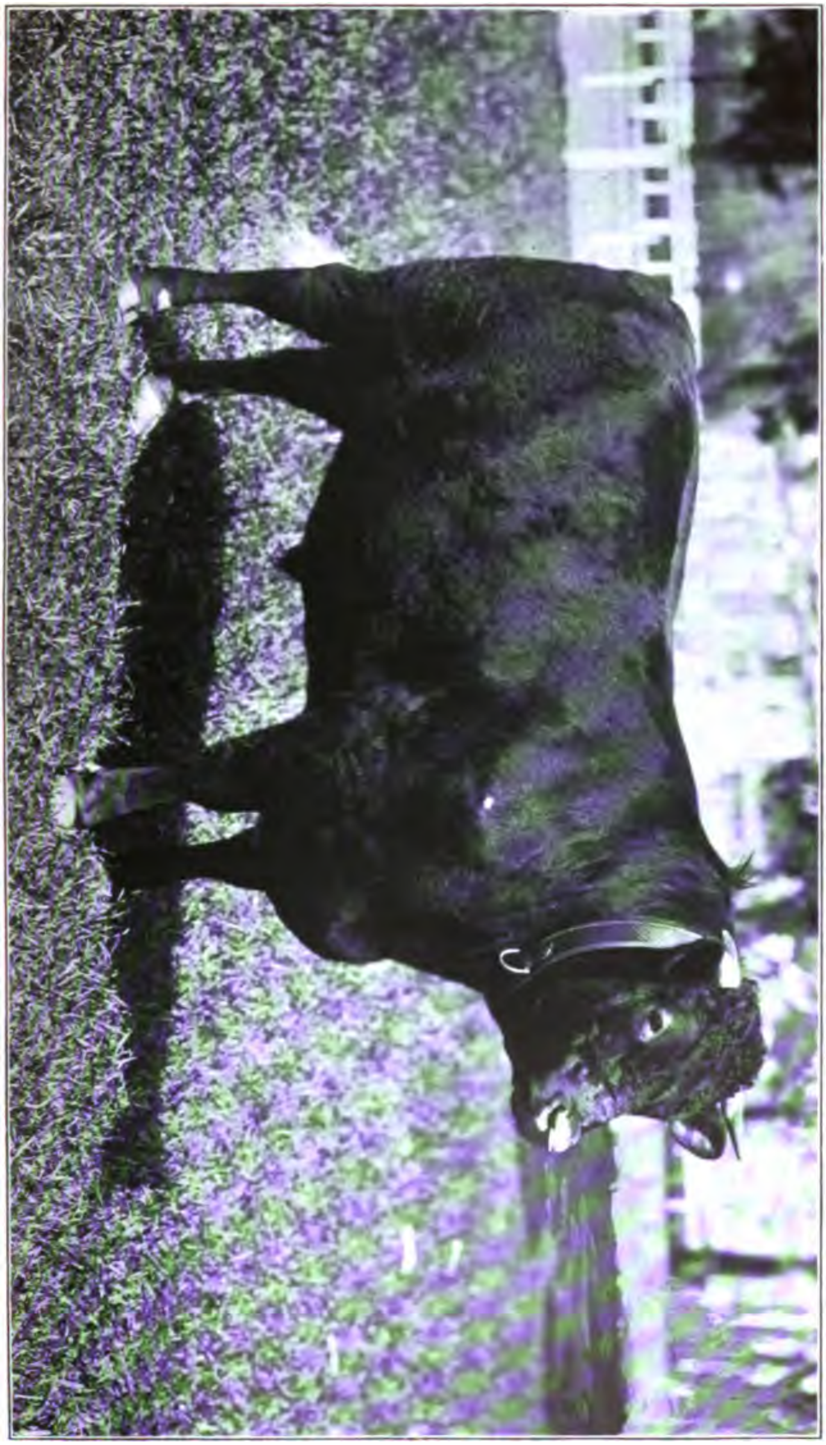
Only 4 Polled Angus bulls were shown for prizes. One was sold for $500 and another went with two 2-year-old cows for $1,300 for the lot. Only 3 Polled Angus cows were shown, the winner of the first prize going with the bull referred to and another cow for $1,300.

A few Holstein bulls were offered, 1 being sold for $1,050 and 2 others for $500 each. Only one prize was awarded, and that to the one that sold for $1,050.

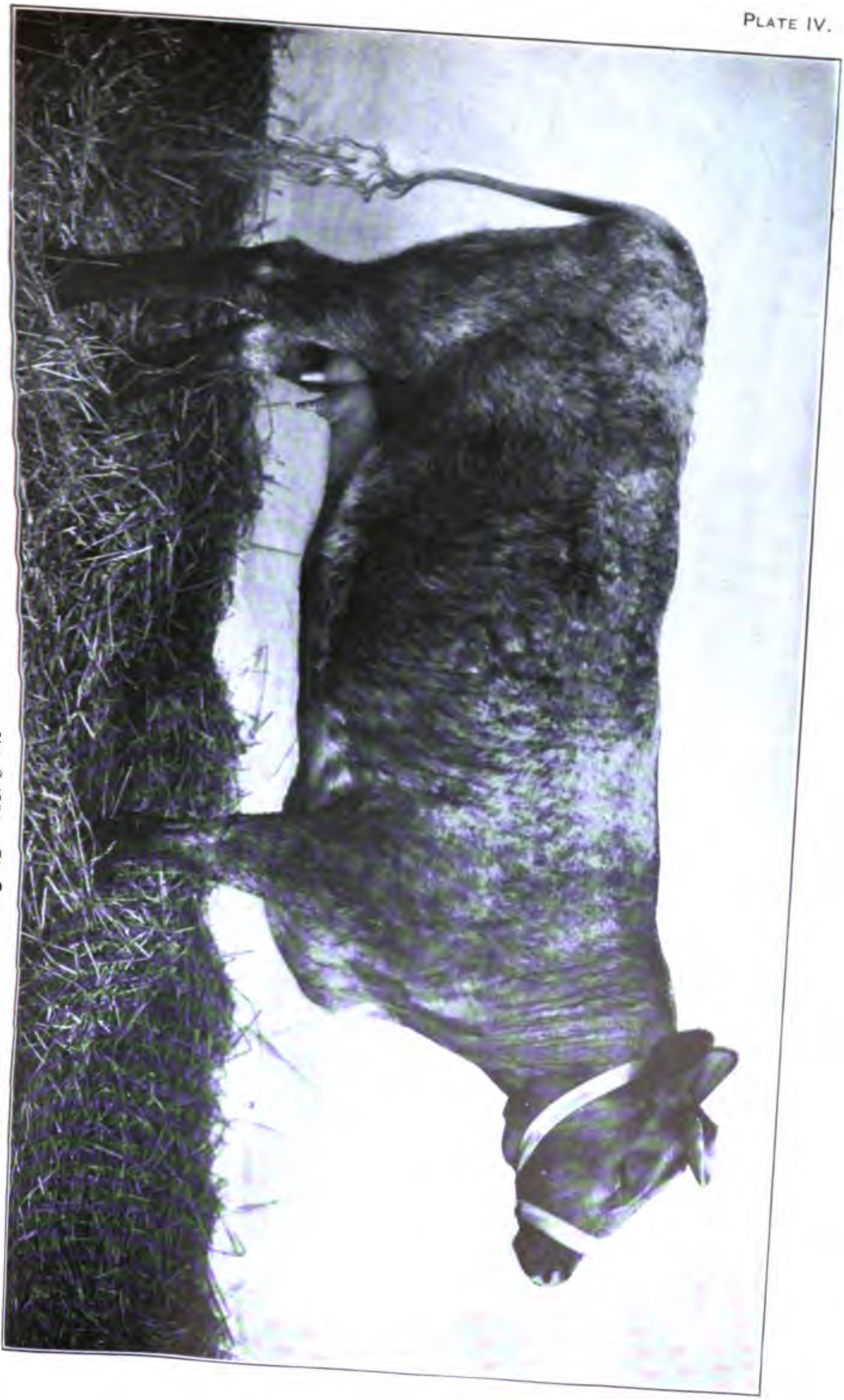
Not a Jersey was to be seen in the show, either for prize or sale. The Jersey herd in Carcarañá, owned by people from the United States who have for years operated a cheese factory there and made it famous, is the only one of any size in the country. Jerseys are regarded as an expensive family luxury and only a few people think of having them, because they do not make beef.

ANIMALS IN GROUPS.

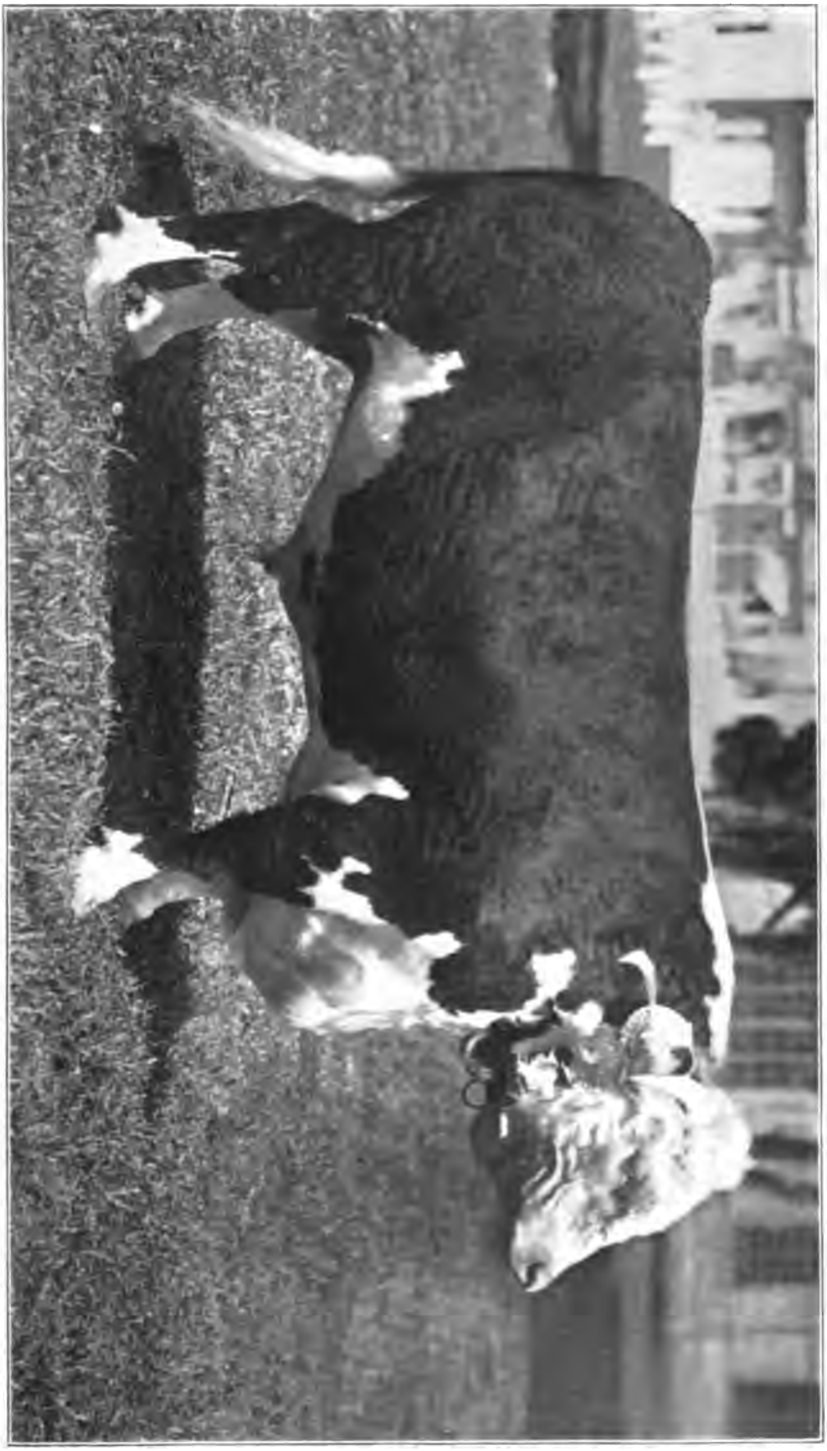
Two groups of Shorthorn bulls of 8 animals each, born in 1900, all registered, the only entries in their classes, sold at $1,000 to $2,100



Farrier Bridekirk, First-prize 2-year-old Shorthorn Bull. Sold for $11,000.



CALOMEL 16, FIRST-PRIZE 3-YEAR-OLD SHORTHORN COW.



GRANDISON 42, PRIZE CHAMPION HEREFORD, 3½ YEARS OLD.

each, one group averaging $1,375 and the other $1,519. Two groups of Herefords of the same grade sold for averages of $700 and $625, respectively, they being the only entries. Two groups of 8 Hereford heifers, the only entries, sold at an average of $270 and $250, respectively. No Shorthorn heifers were shown in groups for prizes.

GRADE ANIMALS.

Under the head of mestizos, or grades, some very satisfactory sales are recorded, showing the readiness of the Argentine breeder to buy animals on their individual merits, without a recognized pedigree and ineligible to entry in the Argentine herdbook, especially if such animals come from well-known breeders and have been sired by registered bulls. The Shorthorn bulls in this category were shown in groups of 8, and there were 35 entries for prizes, the classification being "Grade Shorthorn bulls of two and four teeth." The group that won the first prize was not sold. The winners of the second prize sold for an average of $1,731, and the third prize group for an average of $1,035. Of the 280 animals entered in this class 218 were sold, the average price being $725. The highest price was $2,600 and the lowest $80, the latter for 2 lots only. All the others sold for $250 or more, generally around $600 to $800, while 58 of these young bulls sold for $1,000 or more. The heifers of the corresponding category sold for less than half, and the best of them were reserved from sale. Of the 120 shown, 56 were sold at an average price of $345. The first and second prize winners were not offered for sale, and the lot that won third prize sold for an average of $734—1 of them for $1,000. These bulls were better animals than those referred to in the beginning of this chapter, the "camp bulls in pen," that sold for an average of $395.78. The latter were rougher animals, raised in the camp, never having had any special care, and most of them were not so well bred as the ones just referred to, which were entered for prizes. But many successful breeders are going in for bulls that have not been pampered, but have grown up under the conditions which they must meet on the average estancia that is not breeding show animals, but is aiming to produce the most beef of the best quality at the least cost. It is often said in Argentina that the ambition to produce show animals has resulted in lowering the vitality of the sires. "What we want," breeders often say, "is a good supply of young, hardy bulls that have been raised to camp conditions, so they can go out with the herd, take things as they come, and keep in good condition while doing their work and without watching and special care."

Only 5 Hereford grade bulls were shown under the class provided for them, and they sold for $450 each. Eight Polled Angus heifers sold for $80 each and 8 Red Lincolns for $130 each.

ANIMALS FOR SALE ONLY.

Many animals are brought to the exposition for sale only, not being entered for any prize. Under this head 169 purebred Shorthorn bulls were shown, and 127 of them were sold at the average price of $1,270. The highest price was $6,900 and the lowest $250. Four sold for more than $4,000. These were all from one breeder and were sired by the noted bull Spartan. Three sold for less than $4,000 and more than $3,000 and 16 sold for prices between $2,000 and $3,000. Nearly all these bulls were born between June and December, 1900.

Seven purebred Herefords of the same class sold for prices ranging from $550 to $2,000, or an average of $1,191; 3 Polled Angus averaged $423; 3 Holsteins averaged $550; 5 Flemish averaged $1,010; 20 Polled Angus camp-bred grade bulls sold for an average of $210, and 1 lot of heifers for $45 each. But the Polled Angus is gaining, and many well-informed men in Argentina think it will be the second breed in the country—next to the Shorthorn—though now it is very much below the Hereford in numbers.

Among Argentine breeders there are many wealthy men who will cheerfully pay enormous prices for animals that please their fancy, and they frequently do it. Sometimes this results in stimulating prices to an unnatural extent, but it is certain that superior animals will always find admirers and bring prices that average far above those obtained in the United States. It is true that many good bulls are sold privately in the country at lower prices—from $100 to $200—and that there are plenty of native breeders who have not yet learned that it pays to buy a good bull. There are plenty of rough, miserable cattle in the country, but improvement is going on rapidly, as men see that it does not pay to raise poor cattle when on the same amount of land they might be producing good animals and realizing much larger profits. The great increase in the price of land is also leading estancieros to make the most of it, and they can no longer afford to go on in the old loose way, being satisfied with prices of cattle ranging from $20 to $35. They must double or treble these figures, and they are doing it; but they must continue to import new blood to keep their herds up or they will surely degenerate.

SHEEP.

As noted elsewhere, the significant feature of the sheep sales was the decline in the prices obtained for Lincolns, as compared with the sales of 1901, and the gain in prices and number sold of Rambouillets and the Downs. The Merino type is surely in better demand, more general, and not confined to a few breeders. The highest price for a Rambouillet ram in the 1901 show was $7,300, while in this show the highest price was only $2,000. About 70 per cent more animals were sold in 1902, however, and the average was higher. The Hampshire

Downs held their average well up because they were not numerous and there was a good demand for all. Two lambs 3 months old sold for $175 each, which is said to be the record price for Hampshire ram lambs of this age. The sales of Hampshire Downs, Oxford Downs, and Shropshires during the year following this show did not develop big prices, as it appears that the breeders supplied their wants mostly during the show.

HORSES.

The horse sales were not particularly noteworthy, nor, for the most part, were the horses shown. The horse business at present is not at its best, though good horses may be produced here very cheaply. The heavy horses were criticised because they were too heavy and did not show life enough. Some of the light roadsters, the Hackneys, and the saddle horses were very attractive and found many admirers. These, it will be noted, brought the best prices. The highest price in the sale was for a beautiful dapple-gray Percheron, 4 years old, named Docil. He was one of five entries in his class in which three prizes were offered, but he was not considered by the judges to be worthy of a prize. The winner of the first prize was not sold, but the second-prize animal brought $450, while Docil commanded the top price in the whole show. Many other good heavy colts sold for very low prices, which was rather discouraging to the breeders of this class of horses, for some of them were of excellent type and individual qualities. The sales of heavy draft mares was better than in the May show, as they were more uniform and sold for more nearly uniform prices, though rather low as compared with the prices such mares would command elsewhere. But as these were camp-bred animals, the prices were not so low as they seem to the outsider.

The official report of sales made in the exposition is given herewith as it was prepared by the Rural Society. As published, it contained many errors, but some of these have been corrected. It is still incomplete and inaccurate in some respects, however, and, like some other Argentine official statistics, must be taken in a general way—as an approximation and not as an exact statement. For instance, it will be noticed that the average price of heavy "pen" mares is given at $97.97, while the lowest price is said to be $100, when it was really $32. The highest price paid for a heavy stallion is said to have been $2,400, when one was sold for $2,600. But, in a general way, it gives an idea of the sales in a condensed form. The cattle sales, as given in detail in the foregoing account, were worked out by the author of this report independent of this record.

In this statement of sales, "stall" and "pen" are translations of Argentine classifications "galpōn" and "corral," which are used to distinguish animals raised under shelter and with great care from those raised more or less in the open camp. There is another classification midway between these two, namely, "Criado sistema mixto," meaning, kept part of the time under shelter and part of the time in the open. "Criado á campo" is the expression generally used for an animal that has been raised in the camp altogether.

Condensed statement of sales of live stock in the September-October exposition, Buenos Aires, 1902.

CATTLE.

Breed.		Number exhibited.	Number sold.	Amount of sales.	Highest price.	Lowest price.	Average price.
Shorthorns:							
Stall	Male	301	233	$462,016	$11,000	$400	$1,982.90
	Female	19	6	12,000	2,000	2,000	2,000.00
Pen	Male	1,030	790	402,605	2,600	70	509.62
	Female	469	238	55,930	1,000	40	235.00
Total		1,819	1,267	932,551			
Herefords:							
Stall	Male	33	25	35,349	3,200	500	1,415.96
	Female	7					
Pen	Male	41	28	14,870	1,100	170	513.70
	Female	16	16	4,160	270	250	260.00
Total		97	69	54,379			
Polled Angus:							
Stall	Male	8	5	2,250	550	300	450.00
	Female	7	5	1,000	200	200	200.00
Pen	Male	62	20	6,425	430	100	321.25
	Female	29	16	1,000	80	45	62.50
Total		106	46	10,675			
Holsteins:							
Stall and pen	Male	6	4	2,600	1,050	200	433.33
	Female	5					
Total		11	4	2,600			
Flemish:							
Stall and pen	Male	5	5	5,050	1,250	900	1,010.00
	Female	10					
Total		15	5	5,050			
Dutch:							
Stall and pen	Male	3	3	1,400	560	400	466.66
	Female	5					
Total		8	3	1,400			
Red Lincoln:							
Stall and pen	Male	3					
	Female	8	8	1,040	130	130	130.00
Total		11					
Red Polled:							
Pen	Male	1					
Total		2,068	1,402	1,007,695			

Condensed statement of sales of live stock in the September-October exposition, Buenos Aires, 1892—Continued.

Breed.		Number exhibited.	Number sold.	Amount of sales.	Highest price.	Lowest price.	Average price.
HORSES.							
Saddle:							
Stall	Male	9	2	$2,050	$1,800	$250	$1,025.00
	Female	1					
Light draft:							
Stall	Male	57	28	23,620	2,050	270	843.57
	Female	1	1	350	350	350	350.00
Pen	Female	52	16	2,080	130	130	130.00
Heavy draft:							
Stall	Male	109	83	54,390	2,400	110	655.30
	Female	7					
Pen	Female	78	69	6,759	155	100	97.97
Total		314	199	89,249			
SHEEP.							
Rambouillet	Male	304	213	76,923	2,000	50	361.13
	Female	121	51	3,220	150	40	63.13
Lincoln	Male	832	375	84,371	1,600	35	224.98
	Female	123	84	4,150	210	30	49.40
Shropshire	Male	105	89	8,220	500	40	92.35
	Female	35	5	350	70	70	70.00
Oxfordshire	Male	60	31	6,844	600	50	220.77
	Female	5					
Hampshire	Male	59	31	7,900	600	100	354.83
	Female	74	45	2,250	59	50	50.00
Total		1,718	924	194,228			
MISCELLANEOUS.							
Pigs	Male	8	6	280	50	30	46.66
Poultry		136	31	315	50		
Dogs		12					
Grand total for the show		4,256	2,562	1,291,797			

THE HERDBOOKS AND FLOCKBOOKS OF ARGENTINA.

The Rural Society controls all the herdbooks and flockbooks in the country. The Shorthorn herdbook was started about thirty years ago by several breeders and remained a private concern until a little more than two years ago, when it was purchased by the Rural Society. The Hereford herdbook was purchased by this society several years ago, as was also that of the Red Lincolns. The Polled Angus record was started by the society six or seven years ago. There are no rival herdbooks, and the registration in the society's books is recognized everywhere in the country.

There is a commission of three members for each breed. Each member holds office for two years and is eligible for reelection. This commission passes upon all applications for registration, and though an appeal may be taken to the general board of the society, this has never been done but once, when the commission was sustained. The commission has power to send inspectors to the "cabaña" (breeding establishment) to verify the claim made in the application for registration, but this also has never been done.

Until now any animal that was entitled to registration in the Coates's herdbook of England was admitted to registration in the "Herdbook Argentina." After a long and spirited discussion the directors of the society decided that hereafter no imported Shorthorn can be registered in the Herdbook Argentina unless the first dam and sire of the same inscribed in the pedigree were recorded prior to the year 1850. The argument used to bring about this restriction, which shuts out many bulls that have been going to Argentina from England, was that so long as the Argentine breeders were not permitted to register grade Shorthorns after many years of crossing and improving, English breeders should not be permitted to register animals of five crosses.

Many breeders are in favor of establishing a second herdbook—a preparatory record—in which should be inscribed graded animals after a certain number of crosses, these animals to be eligible to entry in the regular herdbook after a certain number of additional crosses. But these were outvoted when the recent regulation was made.

The beef producer, he who is thinking only of producing good steers, is not particular about the pedigrees of his bulls. He looks to the individual merits of the bulls he is buying first, then seeks to know what breeder they came from, and, lastly, perhaps, to ascertain what sort of ancestors they had. He wants the bull in order to raise steers and has no use for the pedigree.

There are probably not more than fifty breeders in Argentina who are familiar with pedigrees and families and take these into prime consideration in buying bulls. Until very recently the Argentines were thinking wholly of beef. They prefer deep reds and dark roans because, they say, the lighter colors fade out and look very bad in their country.

The certificate of the recognized herdbook in any country will be recognized in Argentina by the Rural Society, provided the animals presented for registration comply with the conditions stated. The American Shorthorn Herd Book has been recognized there before, and so has the Hereford Register. Between the years 1879 and 1887 many Herefords were brought to Argentina from the United States. The certificates of pedigree must be indorsed by the Argentine consul in the port from which the animals are shipped. Animals must be registered within one year after their birth or importation in the country. The fee for the registration of cattle is $5 for each animal born in the country and $10 for each imported animal for members of the Rural Society and twice these amounts for those not members.

The flockbooks are held in small repute by the sheep breeders; not that they are not perfectly regular and of a high standard, but the breeders as a rule do not think it worth while to register their animals, particularly ewes. Only about half a dozen breeders register regularly. Rams must come prepared to register, in case the certificates should be called for, but frequently buyers do not ask for them, particularly if they know the reputation of the place they came from. If from the United States, the certificates would undoubtedly be demanded. The flockbooks are based on the English requirements, and the fee for registration is $1 for individuals and 50 cents per head where the registration is collective, and double these amounts for imported animals. Nonmembers pay double fees. The registration in the flockbooks is increasing, but it will very likely be slow.

The herdbooks and flockbooks are in charge of a competent Englishman, Mr. H. Bruce Percy, who acts as secretary to all the commissions, and is in personal charge of the office in the Rural Society's building in Buenos Aires.

An arbitration board for the settlement of disputes among the members without going into court is one of the benefits open to the members of the Argentine Rural Society. Disputes between members, or between a member and an outsider, may be submitted to this tribunal, which is composed of some of the best men in the country. But both must agree to submit to the decision of the board, and if a member violates the decision he is expelled and posted in disgrace. This board was started about ten years ago and afterwards abandoned, as very few took much interest in it. About two years ago it was revived, but still it is but little patronized. An effort was then made to make it compulsory for both parties to a dispute, if members of the society, to submit their contention to arbitration, which is free of cost, if either party desired it; but this failed.

WHAT ARGENTINE BREEDERS WANT.

An annual exhibition of breeding stock by the Argentine Rural Society will be held during the latter part of September and the first half of October, 1904. At that time the Rural Society's show will probably be an international one, and imported animals may be shown on the grounds; this is not permitted when the show is only national, as it is this year, and imported animals can not be shown for prizes or admitted to the show grounds. Shipments should be made from New York not later than July 1 to 15.

The English ports were opened to Argentine live stock on February 3, 1903, after having been closed nearly three years. A slight outbreak of foot-and-mouth disease on three estancias caused the Argentine Government to close its ports to export animals on May 9, 1903, pending the eradication of this malady, but this may not last more than a few months. The Argentine Government now (June, 1903) claims that the disease no longer exists in the country and is at present seeking readmission to British markets for live animals. The three months during which the export trade went on stimulated prices and taught the producers of fat cattle and sheep that they can only hope to compete with the United States by producing the best animals and preparing them in the best possible manner.

The danger of war with Chile appears to be past and capital is being more freely invested in the country. Agricultural and stock-breeding operations are being and will be carried on with more certainty every year, as the conditions are being studied and fewer mistakes are being made; hence greater profits and more money to invest in improvements of all kinds. Last year was a bad time, as much uncertainty prevailed. The markets were limited to the local demands and three freezing plants and one chilled-meat concern, with what could be worked up in the way of live-animal trade in South Africa, Spain, Portugal, and Brazil, all of which was not much. Of course, there were the saladeros (salting establishments), the makers of tasajo (jerked beef), but these showed a heavy falling off during 1902. But now the country exhibits every indication of a boom. The price of country property has advanced 30 per cent within the year, and there is little dissent from the opinion that these values will be maintained. Alfalfa is taking the place of the unproductive wheat fields, and cattle are wanted to eat the alfalfa, though much of it is exported. Two additional chilled-meat establishments are in process of building and others are in prospect, while some of those already in existence are being enlarged. New areas are being opened up at the southwest, new railway lines are in projection both north and south, and all this means a demand for better and more cattle. The same is true of sheep. A change is taking place, as so well told by Mr. Herbert Gibson in a contribution to this report. A demand is felt which the United States can supply—that is, for good mutton sheep.

PREFERENCE FOR SHORTHORNS.

A glance at the report of sales at the last show, given in detail elsewhere, indicates the overwhelming preponderance of Shorthorns in Argentina. Of all the cattle there exhibited (2,067), 1,824 were Shorthorns, and of the total amount of cattle sales ($1,007,695), the Shorthorns brought $932,581. This is a fair indication of the preference of estancieros in the country. The influence of this great majority of Shorthorn breeders is so great that it is difficult to introduce any other breed, and other breeds do not have the same fair chance that they would if they had more supporters. There are, to be sure, many breeders and advocates of the Hereford as an animal of superior hardiness, good health, feeding qualities under adverse conditions, and a sure breeder. It is generally admitted that the Hereford is better for poor camps than the Shorthorn, and that he is much better able to endure hardship. In most of the tests for fat steers the Hereford has shown a greater percentage of net beef, winning the championship in the May show of the Rural Society for four consecutive years. The objection made to him is that he does not produce a marketable fat steer as soon as the Shorthorn. It is claimed that in the good camps, on alfalfa or the best native grasses, the Shorthorn is ready for market six months sooner and, age for age, produces a heavier, finer-grained animal. So that it is better at this time to take Shorthorns to that market than any other sort of animal.

Argentine breeders have not gone in for any special strain of Shorthorns, except that now the tremendous impetus given to the dairy industry makes the milk strains popular, as, for instance, those of the Bates family. At present the Cruikshank Shorthorns predominate largely. While breeders there will look very carefully to see that the pedigree is all right, they buy on their individual judgment of the merits of animals offered rather than on the certificates of pedigree that go with them. The Shorthorn bulls must be short in the legs, deep and long in the body, with a good head, full, wide chest, well-laid shoulders, strong loins, and well-sprung ribs, covered with deep, mellow flesh, full hind quarters; and his color will please best if it is a deep red or roan, preferably the former. Special stress is laid on the head there. Bulls should be from 2 to 3 years of age, but not less than 18 months old.

DEMAND FOR COWS.

Some first-class Shorthorn cows, especially those known to be good milkers, and heifers of good milking and beef antecedents, will be sure to bring long prices, for they are very much wanted. It was noticeable at the Rural Society's show that the very limited number of cows shown were of inferior quality compared with the bulls. To be sure, breeders do not like to take fine cows to the show, because they must be fattened more than is good for them, and the inducement is not sufficient, as they do not desire to sell them. A good bull may always be had with a fourth of the effort required to find an equally good cow. Notice that while 233 high-grade bulls were sold, only 6 cows were sold in that class. The 238 Shorthorn cows sold were of the corral, or rougher, class, and yet they sold for an average of $235, or $103 United States money. The young bulls of the same class brought an average of $510, or $224 gold, and it must be remembered that a great number of these were not purebred, and so had no pedigree. They were bought wholly on their individual merits, and many of them brought from $1,500 to $2,000. If the cows had been of equal quality they would have brought much more than they did.

These mestizo cows were, in fact, rather inferior, and were the second or third choice of the herds from which they came. Often they were merely the pick of general camp stock, and most of them had no pedigree whatever.

The uniformity of the exhibits of some of the better breeders was an indication that they were paying more attention to the selection of dams, recognizing the folly of wasting expensive bulls on poor cows. A very good authority on the selling qualities of breeding stock in Argentina says:

> There is a good demand for superior cows, providing they be of conditions to enter the Argentine Herdbook. During the year 1902 all pedigree cows, even inferior and old ones, were sold at very good prices. It is safe to say that there is a buyer for every Shorthorn cow, not necessarily a choice specimen, but of good type and antecedents. Cows to bring top prices here must be strong in the hind quarters; they must have unmistakable beef qualities.

As indicated elsewhere in the reference to the dairy industry, there is a demand for some thoroughly good sires of the dairy breeds, except Jerseys, and a few notably good cows. The Holsteins seem destined to play an important part in the future of the Argentine cattle-breeding industry, and so are the Flemish cattle, neither of which can now be imported into this country from Europe. The strength of the Holsteins in the United States ought to give the breeders of that race a good chance in Argentina.

OTHER BREEDS.

Herefords will not bring high prices there, compared with Shorthorns, though an animal that would command favorable attention, a really great sire, would probably fetch $5,000, equal to $2,200 United States money, or possibly a little more. A criticism that is often made of the Argentine herds other than Shorthorns is the lack of really great individual sires. There are breeders of Herefords, Holsteins, and Aberdeen-Angus who will recognize and buy, regardless of price, bulls of the highest merit, but will not look at an ordinary animal. As the importer of these breeds must look to the best breeders for his customers, he must be able to satisfy them.

The following shows a comparison of the prices obtained for Shorthorns and Herefords for three years past in the Rural Society's sales in October:

Prices of purebred and grade Shorthorns and Herefords, 1900–1902.

Year.	Pedigree Shorthorns.	Pedigree Herefords.	Grade Shorthorns.	Grade Herefords.
1900	$1,789	$895	$447	$362
1901	2,277	1,937	486	475
1902	2,891	1,344	524	297

It is hardly fair to the Herefords to make such a comparison without making allowance for several influences on the prices obtained. In

1901 the Herefords were of a better class than in 1902, though the number of bidders was greater in the latter year. So few animals were presented that one or two high prices paid for individuals in 1901 affected the average. Mr. Eduardo Bullrich, a man well informed on live-stock matters, gives the following opinion concerning Herefords, being the result of years of close observation among breeders and estancieros:

> The Hereford is a breed which, for its adaptability to range conditions, hardy constitution, courage, and perseverance, combined with ideal grazing properties, will make its way in our country as well as any other beef breed, though perhaps slowly.

The Polled Angus is making headway and, though but little known, is giving results that are attracting attention. In a circular letter to estancieros advising them what to breed for the new chilled-beef establishment at La Plata, the manager, Mr. Daniel Kingsland, puts Polled Angus second only to Shorthorns. The breed is well adapted to the fine pasturage of the valuable inside camps, as well as to the rougher regions where its vigorous constitution enables it to thrive under conditions that would interfere with success with Shorthorns. Some magnificent steers have appeared in the export markets from the Polled Angus growers. It would not be wise, however, to bring to this market as an experiment more than one Polled Angus bull.

Some first-class Polled Durham or Red Polled bulls ought to find ready buyers, for they have admirers; and there is a tendency among some breeders to dehorn and to strive to produce hornless cattle. The advantages in shipping and handling are sufficient to pay for considerable effort and expense. Dehorning is not much practiced, however, especially upon grown animals. There is a strong prejudice against it on humanitarian grounds. Some breeders and shippers claim that it is an advantage to have the horns in handling cattle on shipboard.

PROFITS OF IMPORTERS.

About three years ago an English importer bought a fine young dark-roan Shorthorn bull at the Belfast fair in Ireland for £105 ($510.98) and brought it with others to Buenos Aires, where the animals were sold at auction. This young bull, Farrier, attracted the fancy of Señor Leonardo Pereyra, one of the most successful and one of the richest breeders in the country. His estancia, San Juan, is the show place of the country, only an hour's ride from Buenos Aires. Here he has 5 leagues, or nearly 34,000 acres, and in various other parts of the country he owns a total of 80 leagues and many thousand cattle. The San Juan place is the old home place, where his father began the improvement of his stock more than fifty years ago, and is used only for breeding stock. Thirty to forty men are employed to care for the beautiful park which he maintains there. Señor Pereyra breeds Shorthorn and Hereford cattle, Lincoln and Merino sheep, and various breeds of horses—always winning many prizes at the shows and getting the top prices for the animals he sells.

All this by way of preface to the sale of the handsome roan Shorthorn bull that pleased Señor Pereyra. He pleased others also, so that the price went up to $15,700, or $6,751 United States money, before the other bidders were willing to quit and let Señor Pereyra have the bull. He has always been well pleased with his bargain, for Farrier has given him about 230 fine calves, among them a prize winner this season, a red bull that was second only to one other in the show in the contest for the championship of Shorthorns. This bull sold for $11,000, or more than the champion. In the show were 8 or 10 others of Farrier's sons, of which 4 were sold—for $900, $3,200, and 2 for $4,200, respectively—the total sales of Señor Pereyra from this bull alone being $23,500 in the auction sales in this one show. Others of Farrier's get were reserved from sale.

The tremendous profit realized by the importer of this bull is not a matter of surprise, though a little larger than is often earned. Many bulls are bought in England for £40 and sold in the Argentine spring sales for from $3,000 to $7,000 paper, or from six to fourteen times what they cost in England. Often breeders in Argentina order bulls sent out from England or Scotland on commission; that is, buyers in England, familiar with the country and the wants of the Argentine breeders, especially their clients, attend the English sales and buy on the order of the Argentine breeders, receiving a good commission for their services. This generally results in the English breeder getting better prices for his animals, for the agent of the Argentine breeder knows his client expects to pay a handsome price, and when he finds an animal that he thinks will suit he bids till he gets it. When two or three of these buyers come together, it is a fine thing for the English breeder. Those who buy on speculation on their own account for sale at auction in Argentina look about for good animals, which can be bought cheap and sold on their individual merits; and they are very successful in the business. Only a short time ago the bull Royal Duke was bought on order from the herd of the King of England for an Argentine breeder, Señor Manuel José Cobo, for £800, and the bull, being old and in poor health, died on shipboard, insured for £1,200.

When the Argentine ports were closed to importations from England, a clever English importer went to the United States and bought a lot of bulls, mostly those that had been brought previously from England or Scotland, and started for Buenos Aires with them. Some of his rivals heard of it, and the ports were closed to animals from the States on the representation that he was bringing animals from England to the United States to be reshipped to Buenos Aires. This decree was issued the day before his animals left New York, but no advice was sent to New York, and he sailed in ignorance of it. The result was that the animals lay in Montevideo for eighteen months or more, until they could be admitted here. A bull named Brave Archer was bought in Chicago for $240 United States money. He had been brought from Scotland about a year before, and though he was a 4-year-old, he sold in Buenos Aires last year for $6,800.

Some recent importations of light-roan Shorthorns from Scotland sold at $1,400 to $2,500, it being the wrong time to offer them, and part of them were withdrawn for later sale. They were not extraordinary animals—some of them being very ordinary —and the prices realized gave the importers a snug profit.

In 1887 some Virginia breeders sent a large consignment of Shorthorns here, and they realized very handsome prices for them, the leading bull bringing $12,000. They enjoyed a good business, but the revolution in 1890 brought it to an end.

HIGH PRICES FOR ORDINARY ANIMALS.

The following recital of the disposition of a certain shipment of cattle is full of suggestion: The shipment consisted of 1 bull, born March 7, 1900, 14 heifers and cows from 2 to 2½ years old, one of them a cow with a young calf, and one 8-months-old calf. Two of the heifers were ineligible for registry in the Argentine herdbook; one of these sold for $600 and the other was withdrawn. The heifer calf 8 months old was sold for $500. The bull was a rather good animal, a deep red, a little rough in shape and faulty in the head, and a trifle faulty in the hind quarters, but in excellent condition, strong, and well developed, and he sold for $3,500. The general comment among those present was that he was a very good bull for breeding steers, but not good enough for a sire of breeding animals. The heifers, with one or two exceptions, were very inferior. They were mostly roans, with two or three reds. They had suffered from long voyages and the unfavorable conditions at Las Palmas, where they spent eight months after having once been rejected at Buenos Aires because they arrived with foot-and-mouth disease. They were very "leggy," a fault quickly to be noticed in Argentina, and most of them were bad in other respects, particularly in the hind quarters. They were all bred to good bulls, and, being young and of good breeding, familiar to the bidders, and brought by a well-known importer, they brought astonishingly good prices. The lowest price was $1,000, the highest $2,000, and the average for 12 was $1,490. They were offered at a very bad season when very few care to buy. If they had been offered at the time of the September show, they would undoubtedly have brought considerably more.

If these animals, which in this country would have been slow sale at $150 to $200 United States money, and might have gone for less, could be sold at an unfavorable time for such good prices, what would be realized for tiptop cows, such as could be sent from the United

States? There is no doubt about there being a good business in taking such excellent animals there. The country is simply hungry for good breeding animals, especially Shorthorns, and cows will be particularly acceptable, because they are badly needed.

FAT-STOCK AND HORSE SHOW.

For several years the Rural Society has given a show in May for horses, fat cattle, and sheep. It is primarily a horse fair, as the sales are chiefly of horses. It is a combination of market and competition for prizes, and many animals are brought to the show to be sold, not being entered for prizes. This show was to be combined with the new agricultural fair this year (see p. 13).

Interest centers in the competition among the Shorthorns for the championship, although for four years prior to 1902 the champion fat steers were Herefords. This is the more remarkable because of the comparatively small number of Herefords bred in the country. In the 1902 show there were twenty lots of 8 steers each competing in the Shorthorn class and only two lots of 8 each in the Hereford, Polled Angus, and Holstein classes. For the Hereford to win under these circumstances, with the great preponderance of opinion against him among the breeders, and hence among the judges, has been a source of much satisfaction to the champions of the breed. In the last show the championship was won by the Shorthorns, but the block test that was made after the award, after the animals were sold and slaughtered by one of the chilled-beef companies, was against the Shorthorns and in favor of the Herefords.

The average weight of the 160 Shorthorns shown, aged about 42 months, was 780 kilos, or 1,719 pounds. They were sold at auction at prices ranging from $110 to $310 per animal, and were bought for export, as all good fat steers were then, by the frozen-meat and chilled-meat establishments. This is equivalent to $48.40 to $136.40 United States money. The average price was $187.75, or $82.61 United States money, or $4.80 per hundredweight live weight. These are extraordinary prices for prize animals, carefully prepared. The lowest weight was 1,531 pounds and the highest 2,008.

The Herefords averaged in weight 1,815 pounds and sold for an average of $200, or $88 United States money. The Polled Angus, with an average weight of 1,318 pounds, sold for an average of $90. The Holsteins showed an average weight of 1,478 pounds and brought an average price of $97.50.

The first-prize Shorthorns, the ones that won the championship of all breeds, weighed an average of 1,931 pounds, and one lot of 8 brought $310 each and the other $270. When slaughtered they dressed out 62.2 per cent of net beef. The second-prize Shorthorns, composed of three lots of 8 each, averaged in weight 1,885 pounds, and they sold for an average of $207. They dressed out 62.8 per cent of net beef. The third-prize group of Shorthorns were the heaviest, averaging 2,008 pounds, but the animals were marked off by the judges for excess of fat and for other reasons. They were sold privately for $310 each, the same price as the champions. No block test was made of these animals, which were exported alive to South Africa.

The Herefords made a fine showing when slaughtered. The first prize lot weighed an average of 1,821 pounds and sold for $205 each. They dressed out 65.01 per cent of net beef. The second prize Herefords averaged 1,810 pounds and brought $195 apiece, giving 62.75 per cent of dressed beef.

No block tests have been reported on the Polled Angus and Holsteins, but the former were not regarded as exceptionally good animals and no prize was awarded them.

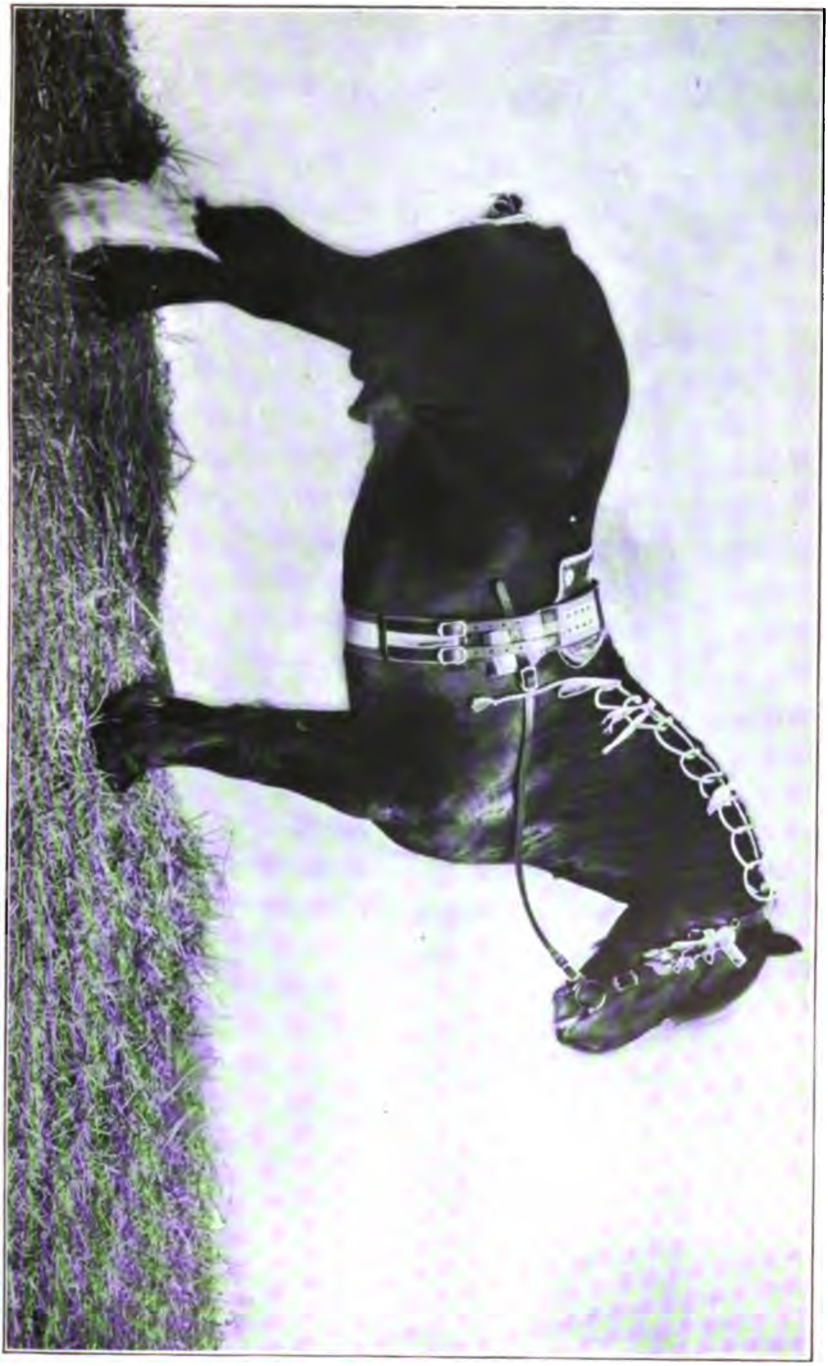
KIND OF CATTLE FOR EXPORT AND HOME CONSUMPTION.

Prior to the opening of the British ports in February, 1903, the best grade Shorthorn steers and other steers that could grade with them were bought for export at $75 to $90 and occasionally a little more for very superior animals. When the English ports were again closed to Argentine live stock (May, 1903), the price for the best grass-fed steers of 3 to 3½ years old, the usual selling age for export, was from $85 to $115. There was a good demand; in fact, more than the supply could meet and maintain its quality for export. Not 5 per cent of these steers had tasted grain, but the majority of them had been fattened on alfalfa and others on native grasses. This quick production and the ease with which such steers are sold has encroached a little more every year upon the reserve supply; that is, younger animals have been sold for export, fewer good steers are killed for home consumption, and more cows, heifers, and calves, as well as inferior steers and oxen, are used to supply the home markets. Thus it is extremely difficult to get a good piece of beef in the city of Buenos Aires. None of the best fat steers—"export type," they are called—are brought to Buenos Aires to be sold, or at least so rarely that the local markets are not looked to for any part of the supply. If a man has a lot of good steers ready for market, he notifies his broker in Buenos Aires, who notifies the buyers, the "frigorificos," and the exporters of live cattle, and the latter send their representatives to inspect the cattle. Then the buyers make bids, either through the inspectors on the spot or through the brokers in the city. Some estancieros get along without brokers and do business directly with the buyers. The prices quoted are for the animals on the estancia, and it costs from $8 to $10 each to bring them to Buenos Aires. The top price of $115 is but rarely paid. The usual price for the best animals is from $100 to $110, and still more are sold to the frigorificos at $85 to $100. Now that the English ports are closed again, there is a decline of perhaps 10 or 15 per cent in the prices of the best steers. These animals range in weight from 1,225 to 1,425 pounds, giving a weight of 700 to 800 pounds of net beef, exclusive of head, feet, kidneys, liver, and other fat and offal. The marketable by-products there are limited and there is much more waste than in the great packing houses in the United States.

The freezing works prefer steers of greater age because of their greater weight, but there is scarcely a good steer in the country that is 5 years old that could have been sold younger. Very few are kept beyond 4 years; selling at 3 years or younger is happening oftener, and is the general rule. Formerly the selling age was 4½ years. Alfalfa has had more to do with getting the animals on the market a year younger than any other one cause. Cattle for the export trade are shipped to Buenos Aires, 450 to 750 miles, but the cheaper grades are driven at least a good part of the distance, as they will not stand the freight charges, and it is much cheaper to drive them to market. The public roads in Argentina are very wide on this account.

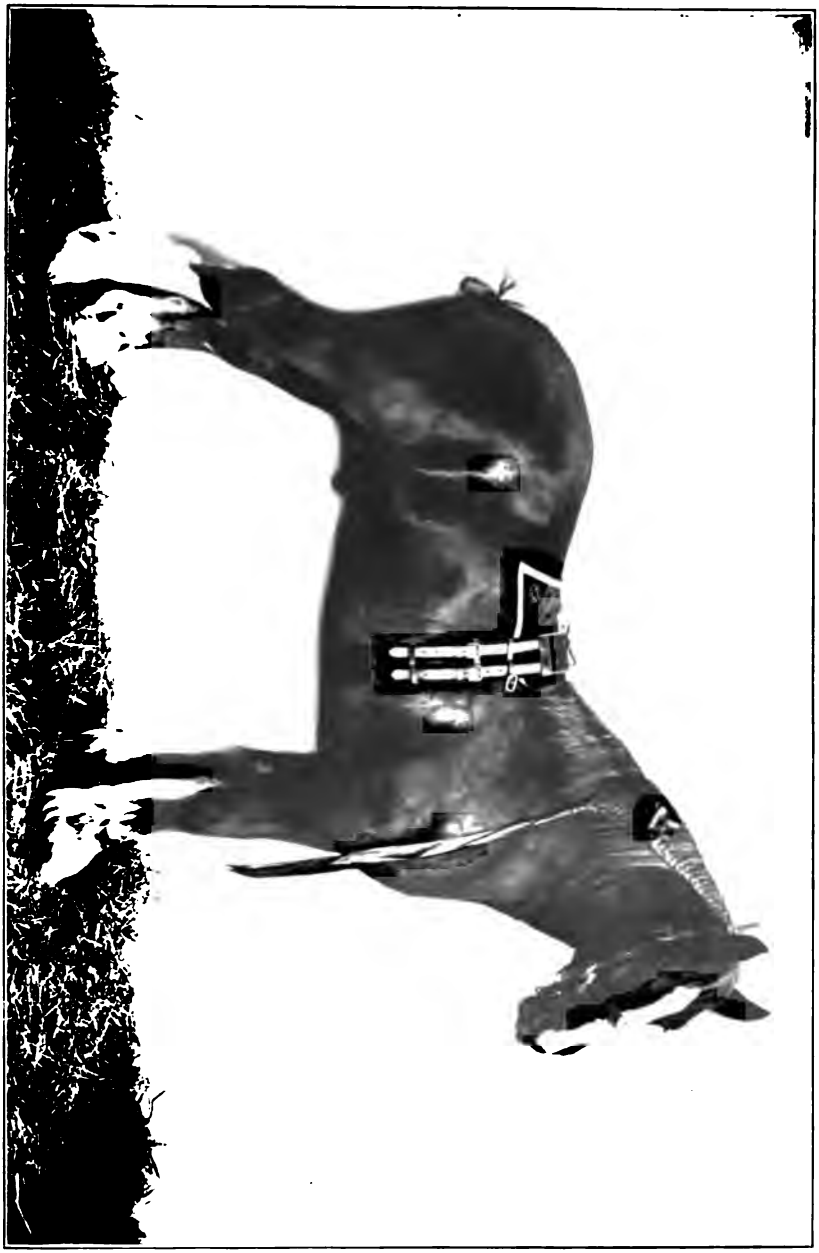
ARGENTINE STEERS ARE GRASS OR ALFALFA FED.

Corn-fed animals are very rarely, almost never, seen. The prices paid for steers by the frigorificos, which, until a few months ago, furnished, and again at the present time do furnish, almost the only market for good steers, did not warrant any corn feeding. A few years ago, before the English ports were closed to Argentine live cattle, so-called corn-fed steers brought $5 to $10 per head more than those that had not received any grain. But these were not really corn-fed, for they had received corn and dry hay for a month or so only before being brought to market, and this in order to teach them to eat it on the voyage. They had their accustomed alfalfa or grass pasture during the day and the corn and other dry feed at night. This system may be resumed this winter if the price of corn is lower than it is now. At present producers of fat steers say it would not pay. Corn is now selling for about 35 to 40 cents United States money per American bushel of 56 pounds. It is claimed by many Argentine breeders and feeders that the alfalfa and grass-fed beef is as good as corn-fed beef, but the best-informed ones—those who know the difference and have seen both kinds—realize that the Argentine, who would get the best price for his steers in competition with those from the United States, must finish them on corn, and this course is being advocated by many who predict that this must soon come. It is likely to be a long time, however, before any considerable amount of corn-fed Argentine beef will find its way abroad. It will require some strong object lessons to convince the great mass of producers, because they are doing very well at present; and until they see Argentine corn-fed steers

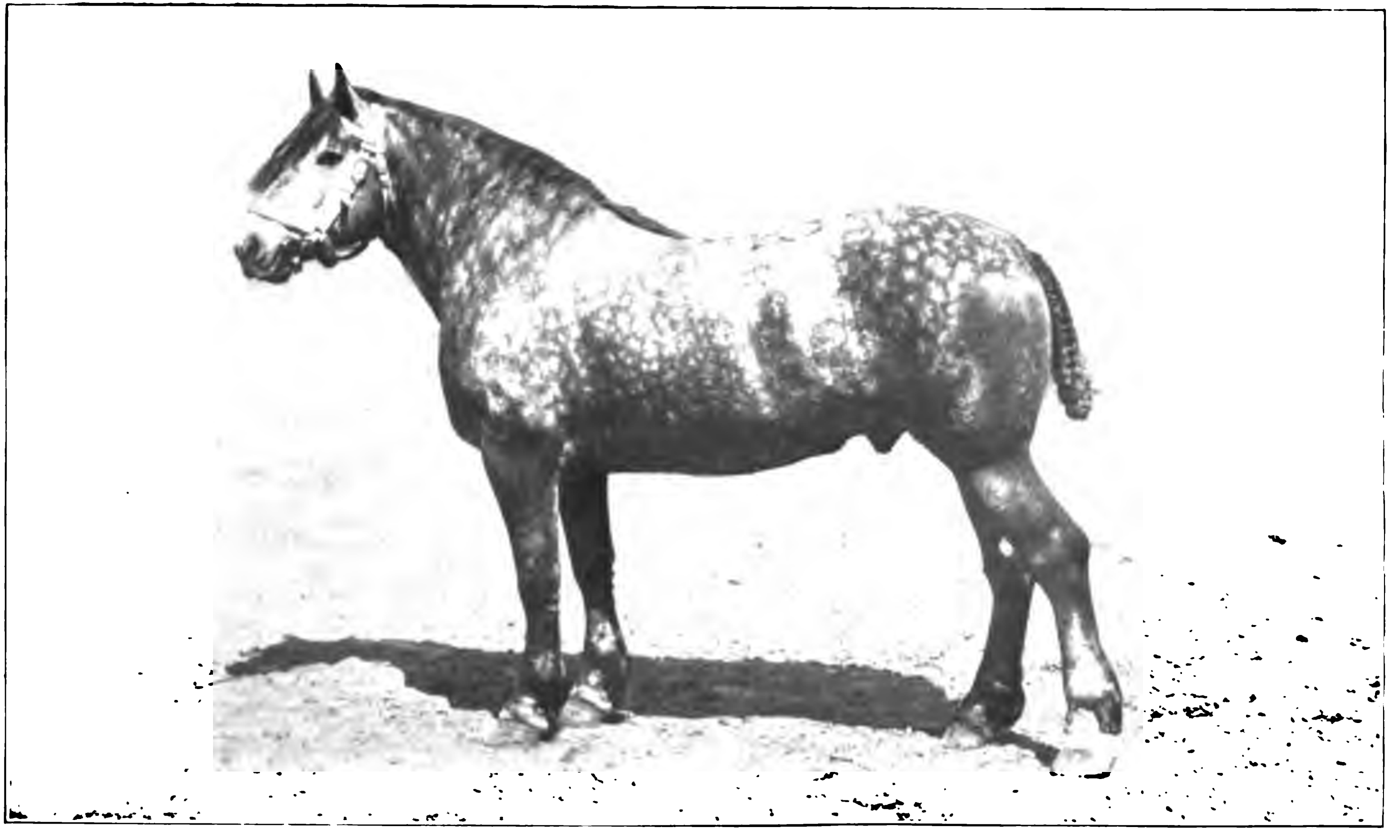


FIRST-PRIZE CLYDESDALE STALLION. SOLD FOR $1,500.

PLATE VII.



FIRST-PRIZE SHIRE STALLION.



Docil, Percheron Stallion, 3½ Years Old. Sold for $2,600.

sold in England for a much higher price than the grass-fed ones they will not go to the trouble and expense of feeding. The present tendency toward mixed farming may bring it about to a certain extent, but the country is at present so divided into "zones" for this and that purpose that corn raising and steer feeding are not very likely to be done on the same estancia to any great extent for several years. The increasing demand for such animals, both in England and the United States, is an influence which will sooner or later bring about their production in Argentina, where they can undoubtedly be grown for many years very cheaply. Some feeders tried corn feeding on a small scale several years ago, with excellent success, but they had difficulty in finding any buyer in Argentina who would pay the difference. One breeder tried the sending of a few on his own account, and he says that he made a profit of over $10 gold per head after charging off all possible expense for feed and labor.

THE MANUFACTURE OF TASAJO DECLINING.

The saladeros are showing rapid falling off in their production of tasajo, or jerked beef, because they can not sell their product at a price that will warrant paying the prices for animals in competition with the frigorificos, the beef-extract factories, the export trade, or even the city market. One great factory has been gradually made over from a jerked-meat establishment into one for the manufacture of beef extract, for which a better quality of meat is used, while only the parts undesirable for beef extract are used for tasajo. One of these companies has just paid a 20 per cent dividend.

MEAT SUPPLY OF BUENOS AIRES.

The beef supply of the city of Buenos Aires comes from one great market, where from 1,200 to 3,500 animals—steers, oxen, cows, heifers, and calves—are brought daily and sold by various commission men to the city butchers. Part of the sales are at auction, but the majority are private. The killing is all done in a place provided by the city and is under municipal inspection. Sheep and hogs, as well as cattle, are all killed here, each man killing on his own account. There is a tremendous waste, especially during the summer, as there is no refrigeration, and all meat is sold the day it is killed, or surely the next day. Many butchers buy carcasses from others who kill by wholesale and supply retailers. If the retailer, when ordering his supply the day before, overestimates the next day's business, he suffers a loss, and it often happens that the price of meat begins to fall before noon and by night is half what it was in the morning, especially if the day has been warm. The meat, besides being usually from inferior animals, is tough and stringy and full of water, shrinking heavily in the cooking. It has had no time to cool, and being grass-fed is watery. Besides, it is sold by the chunk, not by weight, and is cut up in much the same manner as meat is cut for dogs or menagerie beasts. Such a thing as a sirloin or porterhouse steak is unknown in Argentina. The carcasses being hacked to pieces without regard to the choice cuts and sold at a uniform price for the whole, good and bad, makes it very difficult to get a good piece, though sometimes tender, juicy steaks and attractive roasts may be had in the best restaurants and hotels, but it is by no means a sure thing. Several efforts have been made to enforce the municipal law requiring meat to be sold by the kilo; but the butchers are opposed to it, and customers who demand the right to buy by the kilo soon learn that it does not pay, for they get more if they buy by the piece. All these conditions would seem to offer a good opening for a modern fresh-meat establishment in the city of Buenos Aires, supplying good chilled and seasoned meat, properly cut up, with more economical slaughtering and according to better methods.

The prices obtained at the Buenos Aires cattle market vary greatly, according to the quality of the animals offered and the daily demands of the market. For steers the prices run from $30 to $75, the average being probably not far from $50 to $60. For oxen, about the same. For cows, $20 to $60, with occasionally a few at higher prices—those having a little better blood that have been picked up for breeding. Heifers sell at $14 to $30 and calves for from $3 to $18, the average being somewhere around $8. Many of the cows, heifers, calves, and steers sold in this market are not slaughtered, but are bought to stock other estancias. This happens very often at the extremes of seasons or when some part of the country has suffered a drought. Under such conditions estancieros find their camps overstocked, so they keep as many animals as they dare—generally more than they should—and send the rest through this market to some more fortunate part of the country where there is feed.

Prices of meat in the Buenos Aires markets at present (May, 1903) are quoted as follows in paper money per pound and piece, but, as a matter of fact, the prices paid are less, because meat is sold by the lump cheaper than it would be by actual weight:

Beef.—Loin, 20 cents; roast, 25 to 32; boiling, for puchero, the poor man's national dish, 16; steaks, 20; rump, 16; breast, 9 to 13; ox tongues, 80 cents each; Hamburg steak, 22; bones, 9.

Veal.—13 to 36 cents.

Pork.—32 to 45 cents, and ham, imported, $2.04, domestic, 68 cents, the latter being very inferior.

Mutton.—13 to 45 cents.

Lamb.—18 to 36 cents.

Turkeys.—$3 to $6 each.

Fowls.—$1.20 to $1.50 each.
Chickens.—$1 to $1.20 each.
Ducks.—$1 to $1.50 each.
Wild ducks.—40 to 70 cents each.
Geese.—$3.50 each.
Martinettas (similar to quail but larger).—$1 to $1.40 a pair.
Partridges.—30 cents per pair.
Pigeons.—60 cents per pair.
Rabbits.—$1.

SHORTAGE OF COWS IN ARGENTINA.

Returning to the fat-stock show: Some good, fat cows were shown, both Shorthorns and Herefords, but these are only a minor incident of the show and are usually those that have proved useless for breeding purposes. The prices obtained were very poor. The best ones, weighing from 1,400 to 1,500 pounds, were bought by one freezing company—which ordinarily kills no cows of any description—at $62 to $77, and others went for $41. The sacrifice of cows and heifers is one of the most deplorable mistakes now being made in Argentina, and is so regarded by the majority of the most progressive breeders; yet it goes on, as one may see any day by going to the "mataderos," the municipal slaughtering place in connection with the Buenos Aires cattle market. To be sure, a good proportion of these cows are of a very inferior class—"clearings," often, from estancias where the stock is being improved. But the number of cows sold for beef is due, in a large measure, to the demand for beef that can not be supplied in any other way and is another evidence that the number of cattle in the country is overestimated and has probably not increased much, if any, since the census of 1895, which placed the total number at 22,000,000. The country is short of cows, and it can not afford to kill them so long as they are useful for breeding. A proposition to restrict the killing of cows to those over 6 years old met with derision. The Government would like to do something to check this destructive practice, but as yet has not found a practical way to begin it, and the same is true in regard to calves.

These conditions indicate how strong the demand is for cows of good blood. The expositions show it by the small numbers of cows and heifers shown or sold. Those who have good cows do not like either to get them in condition to satisfy show demands or to take the risk and undergo the expense of taking them to the shows, and any good breeder who has good cows never thinks of selling them, but rather of watching for a chance to buy more. High-grade cows, as stated elsewhere, are eagerly sought for, and good prices will be paid for them, and have been paid, and are now being paid whenever they are offered.

SALES OF HORSES IN ARGENTINA.

Of the 413 horses in the May horse fair, only a few were worthy of special notice, and these were the light coach and saddle horses. The prices for the great majority of animals sold were very low, but for some of the prize animals, and for the attractive light coach and saddle horses, the prices seemed to be satisfactory, as prices go in that country. The horse business, while it has improved much, is not in as flourishing a condition as it is likely to be. Hard times, bicycles, electric street railways, and even automobiles, so it is said in the papers there, have hurt the horse business. The highest prices obtained were for coach horses, the lighter ones bringing the best prices. The first prize winner in the light coach class, a hackney Anglo-Norman sorrel mare, brought $2,100, while the third horse in the same class, a gelding from the same breeder, sold for $2,000, and the second prize winner from another breeder, $1,000. The third prize pair in coach horses, Yorkshire-American cross, sold for $1,300. A heavy Shire coach horse, second prize winner, aged 5 years, from an imported sire and purebred mare, sold for $700. The first prize Anglo-Norman saddle horse sold for $300, the second for $250, a few others at $300 to $400, and a number of attractive ones from $100 to $150. A few hackneys brought $600 and $700, but most of them went for much less—around $100 and even less—and hackney mares sold from $45 to $90. The Clydesdales brought very poor prices, and were a rather "logy" lot, most of them, though, of fairly good breeding. Perhaps the fact that grain is not often fed to horses there may have had something to do with this appearance of many horses. The first prize Clydesdales, in groups of 6 colts, sold for $150 each, the second group for $195, and the third for $225. As with the bulls in the fine-stock show, the opinions of buyers do not always agree with those of the judges who award the prizes. Other Clydesdales, pure and of mixed blood, sold as low as $35 and $36, and many went at $55 to $100, though some also commanded from $120 to $180. A great many campbred mares and ordinary geldings found slow buyers at $40 to $60, and even less than the lower figure. Some sold for only $15 each. These horses were not worth more than they brought, for an ordinary horse may be bought any day for $30, or less than $14 United States money. The "cocheros" (drivers of ordinary carriages for hire) in Buenos Aires, who abuse their horses shamefully, find it cheaper to buy a new horse than to feed or take decent care of the poor old animals they often are seen driving.

Some splendid mules were shown—large, strong animals that were shipped to South Africa and sold at a good price. Two lots were especially noteworthy, the result of a cross of a Poitou jack on Clydesdale mares. But an estanciero who has tried them says that his colonists found them too slow and lazy and inferior to the smaller but more energetic mule of the country. Still the large mules are in good demand, and a few big American jacks could be disposed of to excellent advantage. Some Texas stockmen who went to Argentina a few months ago to start a stock ranch and do general farming near Lake Nahuel Huapi, in the southwestern part of the Republic, brought two big jacks, which excited a good deal of admiration, and experienced men wanted to know where more such animals could be had. The mule business was a very profitable one for Argentina during the Boer war, and the country, especially the northern part, in the province of Córdoba, has been pretty well drained of mules. The business is practically over now, but breeding is going on, and the demand for mules and for jacks is good.

SALES OF SHEEP IN ARGENTINA.

Only 240 fat sheep were exhibited in the May show, for at that time sheep breeders were rather discouraged, or had been for a year. The prices, both of wool and mutton, were very low. Plenty of sheep were sold in the early part of the year 1902 for $1 to $1.50. Fat sheep, fit for export, were bringing only $4 to $5.50, and the market for these was confined to the three freezing works. There is record of the sale of three lots of these sheep, 120 in all. Two lots of 40—one of Lincolns and one of Hampshire Downs—sold for $5.50 each, while another lot of 40 Lincolns went for $4.80.

ANIMAL SANITARY REGULATIONS.

The Argentine Government devoted much effort during the year 1902 to the task of persuading the British Board of Agriculture, not only that Argentina is free from foot-and-mouth disease, but that there is no danger of its being brought into the country from its neighbors, especially from Uruguay, and in turn sent again to the foreign cattle markets in England. Many times it seemed that the English ports, closed to Argentine cattle and sheep in April, 1900, were about to be opened, but some new objection from the British Board of Agriculture would prevent it. The influence of the English meat producers was very great and the English breeders seemed to be in great fear of another outbreak from imported infection. But at last the Argentine Government was able to comply with the conditions imposed by the British Board of Agriculture, and on February 3, 1903, the bars were let down, permitting Argentine sheep and cattle to be sent to the English ports alive under conditions similar to those required of importations from the United States. The conditions required of the Argentine Government were not severe, once the fact was established, as it undoubtedly was, that foot-and-mouth disease did not exist in Argentina and had not for a year been within the limits of the territory from which cattle are exported or alfalfa shipped that could be infected. The best authorities in Argentina do not deny, but freely admit, that foot-and-mouth disease is liable to appear at any time in places, and it exists now in some of the distant provinces, from which cattle are not exported and but seldom brought directly to market. They are brought to better camps to be fattened before they are exported or slaughtered, and the contention is that the system of inspection within this territory is so thorough that the existence of the disease is detected immediately upon its appearance. Rigorous measures are then taken to confine it, and it is soon stamped out. So men like Ronaldo Tidblom, the chief live-stock authority of Argentina and director of the bureau of animal industry, claim that there is no danger of infected animals being exported or of arriving with the disease. No animal can be exported without having first been inspected on the estancia by a Federal Government inspector and again in the port of Buenos Aires, Rosario, or La Plata, whence animals may be exported.

The recent outbreak that caused the Argentine Government to promptly prohibit exportation of all kinds of live animals to whatever destination was confined to three estancias within 65 miles of the city of Buenos Aires. It first appeared among some imported animals undergoing quarantine in the port. The first animal showing the disease was promptly slaughtered. In a day or two 2 other animals appearing infected were also slaughtered. The next day 7 more showed the disease, and by this time the origin of it had been traced to green alfalfa brought from an estancia which was shown to have the disease. Thereupon, it being proved that the animals had not brought the disease with them from England, and that all were infected, no more were killed, and all that pass the tuberculin test at the termination of the quarantine, after they recover from the aphthous fever (or aftosa, as foot-and-mouth disease is called there), will be admitted the same as if they had not had the disease. In the meantime the places of its appearance were quarantined. The authorities do not anticipate any further spread of the disease and expect it will all be over in a month or so.[a] The closing of the ports was out of regard for the English fear of the disease and to show a determined effort to maintain a clean bill of health.

The close proximity of the Republic of Uruguay, where more or less the same conditions prevail as in Argentina, led the British Board of Agriculture to insist that the Argentine Government must either induce Uruguay to adopt the same regulations or exclude Uruguayan cattle altogether from the country. The negotiations with Uruguay were attended with difficulty. The saladeros, or jerked-meat factories, on the Uruguay River, on both sides, get their cattle from both sides of the river. The stockmen of the Argentine province of Entre Rios sell many of their cattle to the Uruguayan saladeros, and the Argentine saladeros get cattle from Uruguay. There were other dealings in feeders and fat stock, so the suspension of this traffic would have entailed heavy losses. The last point discussed was the desire of Uruguay to be allowed to load live stock on the same ships with Argentine animals for England and other points. This was not agreeable to the Buenos Aires Government, as it would involve additional risk of disease appearing among the animals on the voyage and there would be no way of knowing in which country it originated. Finally the Uruguayan Government agreed to the conditions, as it shares, on equal terms, in the benefits of admission to the English market, while the work of removing the obstacles has been done by the Argentines.

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[a] Since this was written the Argentine Government has declared officially that the disease no longer exists in the country.

The Governments of Argentina and Uruguay have made regulations in substance as follows, governing the importation and exportation of animals, in compliance with the demands of the British Board of Agriculture:

Article 1 prohibits (*a*) the importation or landing of animals, animal remains, etc., from any country where dangerous contagious or infectious animal diseases exist; (*b*) the importation of animals from a country whose laws do not, in the opinion of the executive, offer sufficient guarantee against contagion; (*c*) the importation of animals from abroad through any other port than Buenos Aires; (*d*) the importation of animals from any country that have originally come from a prohibited country; (*e*) the importation of animals in a ship which has, within thirty days of its embarkation, loaded animals in a prohibited country; (*f*) the importation of animals in a ship which, after loading, has been in contact with any kind of animals proceeding from a prohibited country, or which has called at any port of such a country; (*g*) the entry into an Argentine port of any ship which has, during the preceding sixty days, loaded animals of such a country; (*h*) the importation of animals having "garrapatas," or Texas fever ticks.

Article 2 prohibits the exportation of animals attacked by contagious diseases, or suspected of being so, or bruised, and of those that have not undergone veterinary inspection on the estancia and at the port of embarkation, and that have not been transported in disinfected vehicles. Also exportation in a ship which has on board animals from a prohibited nation or that has not been disinfected after having remained in or touched at, during the preceding sixty days, the port of a nation under prohibition by reason of the cattle plague, or during thirty days, if prohibited on account of the existence of pleuro-pneumonia, foot-and-mouth disease, or glanders; also the exportation of cattle having the Texas fever ticks.

The importation of all classes of animals from Russia, Roumania, Servia, Cape Colony, Natal, Orange River Colony, and other British colonies in South Africa; the German and Portuguese possessions of East and West Africa, the French possessions of West Africa, and Madagascar, Bolivia, Ecuador, Peru, Venezuela, Colombia, and English, Dutch, and French Guiana is prohibited.

Importation of cattle, sheep, goats, and hogs from the continent of Europe, Australia, Brazil, Chile, Paraguay, and from the States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island, of the United States, is prohibited. There is no prohibition against the rest of the United States, the New England States having been included in the prohibited list because of the outbreak of foot-and-mouth disease there. This prohibition will be removed when the disease, in the opinion of the United States Department of Agriculture, is effectually stamped out.[a]

Article 4 requires that animals imported must be accompanied by a certificate (in the United States from the Department of Agriculture) showing that the cattle plague has not existed for ten years in the country from which they proceed; and that neither pleuro-pneumonia nor foot-and-mouth disease has existed there during the preceding six months; that as regards sheep it must be shown that no case of small-pox in sheep has occurred during the six months; as regards horses a similar certificate in reference to glanders and lampas. This certificate must be indorsed by the Argentine consul at the port of embarkation.

Provision is made for the inspection of ships bringing live stock and for segregation and quarantine, or destruction if they have the prescribed diseases, of animals not found in perfect sanitary condition.

Article 6 specifies the quarantine and inspection of animals imported, as follows: Cattle, 40 days, during which neither the owner nor anyone representing him may have access to the animals. At the expiration of this period cattle are subjected to the tuberculin test, and if they react, showing that they have tuberculosis, they must be slaughtered without compensation or removed from the country within 8 days. Sheep are to be kept in quarantine and isolated for 15 days and horses for 8 days. Horses may be tested for glanders at the expiration of the quarantine period, and if they have the disease, or if they have been in contact with horses suffering from glanders, must be slaughtered without compensation. The length of the quarantine is at the discretion of the director of the division de ganaderia (bureau of animal industry) and may be extended, though it is not likely to be.

Special provisions are made for commerce between the Republics of Argentina and Uruguay, requiring thorough inspection and dipping in the official dipping places for killing ticks. Importations from

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[a] Foot-and-mouth disease has entirely disappeared from the United States, and on July 20, 1903, the Secretary of Agriculture issued an order reopening the port of Boston for export cattle.—EDITOR.

Uruguay are not subject to the same regulations as other countries, the certificate of health of cattle and other animals being more inclusive and being given from each section of the country from which animals proceed.

CONDITIONS AND COST OF ADMISSION OF BREEDING STOCK.

All breeding stock is admitted free of duty. Importers should form a connection at Buenos Aires before shipping, as it will be a great advantage upon arrival.

The auction house of Adolfo Bullrich & Co., of Buenos Aires is one of the most prominent in Argentina; in fact, it sells more than half of all the breeding stock sold in the country. The founder of the establishment has been mayor of Buenos Aires two terms, and he will spend some months this year traveling in the United States studying our breeding establishments. His son, Eduardo Bullrich, is the manager. These men speak English and have a wide knowledge of the country and large acquaintance and influence with breeders of Argentina.

Breeding stock, feeding stock, farms of all kinds, city property, and almost everything, in fact, is sold at auction in Argentina. The sales are held in a great market, running through from one street to another, in the very midst of the business district. Here the animals are kept on exhibition for two or three weeks generally previous to the sales. The sales are well advertised and are attended by the leading breeders, especially during the spring sales—in September and October.

The service in the embarcadero, where animals are detained during quarantine and the owners are not allowed to see them, is generally quite satisfactory to the English importers of Buenos Aires. There has been no complaint aside from one lot, but, on the contrary, the service has been complimented. There is no cause to anticipate any trouble or excessive charge, the regular rates being given herewith. The auctioneer's commission is 6 per cent on sales, and the other expenses upon arrival in Buenos Aires, aside from personal expenses, until the animals are sold, are as follows:

At the landing stage, or embarcadero:	
Unloading cattle or horses, per head	[a]$2.00
Unloading sheep, per head	.50
Feed (hay, maize, and bran) per diem per head—	
Cattle and horses	1.50
Cattle and horses, with oil cake and oats	2.00
Sheep (hay, maize, and bran), per head	.40
Entrance and crane fee (Government tax on landing stage)—	
Cattle and horses, gold	.05
Sheep, gold	.01

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[a] All reference to money, unless gold is specified, is in Argentine paper, worth 44 cents in United States money on the dollar.

Clearing at the custom-house:	
Stamps for clearing, $1 per $1,000 declared value.	
Stamps for documents, $6.75 on each consignment.	
Fee of custom-house broker, from $10 to $25, according to shipment.	
At the auction house:	
Feed (hay, maize, bran, and oil cake) per diem—	
Cattle and horses, per head	$2.00
Sheep, per head	.50
Driving from landing stage pens to auction mart:	
Cattle and horses, per head	1.50
Cartage of cattle, according to number of animals, as may be arranged.	
Cartage of sheep per cart	2.00
Receiving animals and delivery at auction mart is gratis.	

So little business has been offered in recent years that there are no regular fixed rates on the shipment of animals from New York to Buenos Aires. Four English companies run regular steamers direct from New York to Buenos Aires, and they have all expressed a willingness to accommodate shippers of pedigreed stock to a greater or less extent. These companies are the Prince Line, the Lamport & Holt Line, the Norton Line, and Houlder Brothers. The rates are as follows, in United States money: Cattle, $55 per head; sheep, $13.20 per head; horses, $82.50 per head; donkeys, $27.50 per head.

The animals will usually be carried on the after deck, in the open, with proper cover. The voyage, except the last four days, is a smooth and warm one usually, especially in the season when shipments should be made. From Rio de Janeiro to Montevideo it is likely to be cool and rough in July and August, so that precautions should be taken to protect the animals.

The steamship company supplies nothing but water to the animals. All feed must be supplied by the shipper, but it is carried free unless there is a large amount in excess of what is required; in that case it is charged freight at the rate of $3.86 per ton. Where 6 cattle, or 35 sheep, or 4 horses are shipped at one time, free passage is given to one attendant unless he requires cabin accommodations, in which case he is charged $50 passage money. The voyage is not an unpleasant one; the ships are fairly comfortable for a few passengers, and it is highly advisable that valuable animals should be in the care of some one who understands them and is personally interested in their welfare. Arrangements can be made with the captain of the ship for the care of the animals by the crew, however, for a small fee. It is of the utmost importance that the animals shall have plenty of cool, fresh water during the voyage, not only for drinking, but for bathing the animals while passing through the Tropics. Salt water will not do, as it causes irritation of the skin and makes the coat look rough. Coal dust has the same effect. Stalls should be padded for the same reason, as it will pay to make sure that animals arrive looking as well as possible. A laxative should be provided for use while passing through the Tropics. The length of the voyage varies from twenty-three to thirty days.

Insurance on the animals against all risks may be had in reliable companies for from 5 to 10 per cent, depending upon the line and the ship, and it is advisable to carry insurance, as the steamship company does not assume any responsibility.

THE DAIRY INDUSTRY.

During the year 1902 Argentina exported 9,308,200 pounds of butter, chiefly to England and South Africa. This was an increase of 187 per cent over the exportation of the previous year, which was 3,232,391 pounds. There are no statistics of production for home consumption, but the best estimate available –that of the Rural Society—puts the production of the province of Buenos Aires at 20 tons per day. The production and consumption of butter outside this province is not possible to estimate closely, but certainly all the rest of the country does not produce 10 per cent of the amount produced in this province, if we leave out of the account the amount produced and consumed in the city and vicinity of Rosario, the second city of the Republic, having a population of over 120,000. Even this city is supplied, to a large extent, from the province of Buenos Aires, for as yet only a small proportion of the estancieros are making butter. The private production and consumption must also be omitted in this comparison, for that is increasing on the estancias. Still there are thousands of people owning various numbers of cattle who either go without butter or buy it in the towns.

The city of Buenos Aires, with its 876,000 people, is, of course, the chief local market for Argentine butter, and it is well supplied with a very good quality. The consumption is estimated at only 4½ pounds per capita per annum. The working classes do not have butter on their tables as they do in the United States. The present price in the city is about 22 to 24 cents gold per pound.

To supply the demand there are four great factories or systems of factories. Their plan of operation is something unique. The industry is, of course, only in its incipiency, but it is interesting to note the process and rapidity of its development, its extensive possibilities, and the probability of its immediate and tremendous growth.

La Union Argentina, the chief butter maker of Argentina, is a cooperative creamery on a very large scale. It was organized in 1899 to save the butter industry from the collapse that threatened it, which was due to the wastefulness of small individual production and the lack of uniformity and modern methods. The last report of the

Argentine Rural Society gives an account of the organization and operation of La Union Argentina, which is in substance as follows:

> The applicant for membership must be a producer of milk, agree not to dispose of it or any of its products except through the society, and he must own five shares. But one need not be a member in order to receive the benefits of the organization, since members and nonmembers are treated alike in the charges for services rendered, and are paid the proceeds of sales in the same manner and at the same time. The society receives any amount of milk or cream from any person, whether member or not, to be made into butter. Patrons of the society pay the expenses of the creamery—freights and other expenses—in proportion to the value of their consignments. Those who send milk are not charged for the use of the separators. A commission of 8 cents paper per kilo is charged on the butter made from either milk sent in and separated or from cream that has been separated before being sent to the factory. This amounts to about 1.6 cents gold per pound, and is to cover the following charges:
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> (1) Freight charges on milk or cream.
> (2) Cartage on cream from the railway station in Buenos Aires to the factory.
> (3) Attending to orders for utensils, for fuel, instructions, etc.
> (4) Cans for transporting cream.
> (5) Inspection of the separators by frequent tests of the separated milk.
> (6) Making, care, and sale of butter.
>
> The society does not purchase milk or cream, nor does it guarantee any fixed price for the butter made from either. After testing each consignment it is made into butter, and the directors fix the basis for making up the monthly accounts in accordance with the prices obtained.
>
> The society had thirty-five producing members on the 1st of May, 1899, and the increase has been so rapid that in September, 1902, it had 1,134 consignors of milk and cream, members and nonmembers, and forty-three creameries throughout the province of Buenos Aires and two in Entre Rios. Since the latter date four new creameries have been started in the province of Entre Rios. These new creameries were started by the producers subscribing for the stock to the extent of the cost of the machinery, at the same time declaring in writing how much milk each can furnish daily. Each of these creameries is separating about 7,000 quarts of milk per day. The society has many cream-separating stations throughout the country, wherever the milk can be obtained in sufficient quantities. The daily production of the society is now about eighteen tons.

A creamery in Argentina means a place where cream is separated from milk and the cream sent to the factory in the city to be made into butter, cheese, or other milk product. What we understand as a creamery is called a "fabrica de manteca," or butter factory, in Argentina. La Union Argentina makes all its butter in Buenos Aires, receiving cream from many stations, or creameries, scattered all through the provinces where dairying has been taken up. Two of these stations are in the northern part of the Province of Santa Fé, in the Jewish colony. The cream is sent daily to Buenos Aires, twenty hours by train, in all weather, without ice. The colonists get about 2½ cents paper per liter in winter and 3½ cents in summer for their milk, equivalent to a trifle more than 1 cent gold per quart in the winter and 1.4 cents in the summer, with which they are well satisfied. They set the cans containing milk out in the road in the hot sun and the creamery wagon comes along and picks them up, dropping the empty cans in the same manner. The skimmed milk is used at the creamery to feed pigs.

The railway rates for the transportation of milk and cream, per 100 kilos (220 pounds) are as follows, in Argentine paper money:

Less than 50 kilometers (31 miles): Southern, $1.36; Western, $1; Rosario, $0.90; and the Pacific, $0.73.

From 50 to 100 kilometers (31 to 62 miles): Southern, $1.57; Western, $1.20; Rosario, $1.70; and the Pacific, $2.40.

From 200 to 300 kilometers (124 to 186 miles): Southern, $2.18; Western, $2.86; Rosario, $3.40; and the Pacific, $6.

From 300 to 900 kilometers (186 to 559 miles): Southern, $2.27; Western, $3.64; Rosario, $4.30; and the Pacific, $9.

The Jewish colony referred to ships by the Rosario line and pays the highest figure, as it is 355 miles from Buenos Aires. There is much complaint, especially from dairymen near Buenos Aires, of the high rates of transportation maintained by the railways.

The society protects the reputation of its butter product by requiring every exporter to brand the cases "Producto Argentino," and to receive shipments on shipboard directly from the society. The price obtained by the producer is not far from 80 cents paper per kilo, or 16 cents gold per pound. The average price in London in 1902 was about 22.5 cents gold per pound, leaving a comfortable margin to cover the cost of shipment and give the exporter a satisfactory profit. The average Buenos Aires prices, in December, for four years, have been, in gold, as follows: 1899, 19.2 cents; 1900, 19.6 cents; 1901, 20 cents; 1902, 18.2 cents.

Argentine butter has won a good reputation in the English markets, and has been sold in competition with the French, Holland, and Australian products at prices almost as good as the best, and it has been gaining in price as well as in quantity exported. The amount of the exportation is increasing rapidly, as new creameries are being erected, and the capacity of those already in operation is being enlarged. New territory is being opened up and separating stations established, where the milk is brought and the cream taken out and sent to Buenos Aires or some other place to be made into butter.

Argentine butter is of a very good quality, and uniformity is secured by the large production under one management. It lacks the firmness and grain of United States butter, however, and even without considering the fact that it is never salted, unless so ordered, it does not seem to have quite the rich flavor of that made in the best creameries in the United States. However, it suits the European market very well and is gaining ground there. The South African market is also an important one for Argentina in this respect, as in others. The salted butter, which is worked twice, being left to stand over night after salting, is of a very fine, even quality, firm and rich in flavor, and compares very well with that made in the United States.

The city of Buenos Aires has three great dairy companies that supply all milk products to the people at retail and also make some butter for export and for sale outside Buenos Aires. There are two or three other butter manufacturing companies that buy milk and cream and export butter, and within a year or two these will be numerous.

The dairy business in the city of Buenos Aires is interesting and in some ways unique. Three companies have large dairies of their own, where attention has been for some years given to the breeding of milch cows. The peculiarity of the dairy industry there is the establishment all over the city by these three companies of little lecherias, or milk depots, where milk is sold in every form, both fresh and manufactured. These little shops are located in all parts of the city, even on the principal shopping streets, and are very clean and attractive. The interior is always painted white, and the attendants are usually young women. Milk as a beverage is popular, and all these places have it fresh, sweet, and cool, and also buttermilk and other milk beverages. A large glass of milk costs 10 cents paper, or a little over 4 cents of our money. It is estimated that the three companies sell daily from 18,000 to 19,000 glasses. The daily consumption of milk in the city is about 200,000 liters, or 211,340 quarts. These hygienically conducted establishments sell about one-fifth of it The rest is sold in a multitude of ways by small dairies. Many of them drive the cows about and milk them in the streets as the milk is called for by their patrons. Others do not take the cows out, but keep them in prominent places in the city, and milk them on order, so people can see what they are getting. Some lecheros (milk sellers) still go about in the old fashion, with milk cans on horseback, as they still do in the provincial towns. The three companies referred to sell milk at 15 cents per liter, or 20 cents delivered. The prices obtained by the other milk sellers range from 8 to 20 cents paper per liter, according to the quality of the milk and the repute of the dealer. The city has a system of inspection of milk, but through lack of sufficient inspectors it is not very efficient. The milk is usually of a fair quality, and that of the three companies is always good. Sterilized milk, which they prepare and sell in sealed bottles, is much used.

Two of the three companies have contributed to the advancement of the dairy industry by the development of manufactured products from it. One has two fine estancias about 60 miles from Buenos Aires stocked with about 2,000 cows, as well as other stock. The cream is separated from the milk on the estancia, and only the cream is sent to the factory in Buenos Aires. Casein, also an important export product, is taken out of the milk after the cream has been extracted, and what remains is fed to pigs. Besides butter and sterilized milk, the dairy companies make a preparation peculiar to Argentina, known as "dulce de leche," literally, "sweet of milk." This confection is made by boiling whole milk and sugar for several hours, with constant stirring, until it becomes very thick, a sugary paste that is delicious as a dressing or as a dessert by itself, and is very popular there. The people make it themselves and use it freely. Condensed milk of excellent quality, both sweetened and natural, is made by these companies. Another milk product that has found high favor in Buenos Aires is that known as "leche maternizada," or baby's milk. One company has been especially successful with this milk prepared for infants. It is put up in sealed bottles, and it retains its sweetness without carrying any deleterious substance. People taking long voyages often take hundreds of bottles of this milk for the use of the baby. The same company makes fine toilet soap and several other products from milk. Two put up butter in small tins, also sterilized milk, for export.

The keen rivalry among these companies, especially the two best known, shows the interest taken in the development of the dairy industry. Their exhibits at the recent show attracted more attention than any other feature. The business in all these lines is developing with a rush, but it is certainly permanently established and destined to be one of the chief sources of Argentine wealth. The waste of milk that has been going on in the country has begun to decrease; estancieros are beginning to understand the importance of making the most out of the milk and to see the mistake they have been making in allowing the calves to have it.

SELECTION OF COWS FOR MILKING QUALITIES.

Estancieros are looking to their breeding to get milking qualities, something to which the average breeder has given no thought heretofore. The dairy breeds, except the Jersey, are attracting more attention. For this reason milk-giving Shorthorns will commend themselves to Argentines, provided that they are also meat producers; that is, a Bates cow or bull, known to have a good milk-producing inheritance, will be regarded very favorably, provided the animal promises to produce first-class beef animals also. Formerly nothing but beef was thought of; cows were rarely milked, and calves ran with their mothers until they were 8 or 9 months old. Now they speak of taming cows to milk as they would of breaking a wild horse. The progressive breeders and estancieros are making selections of their cows with regard to their milking qualities, and are seeking to improve the amount and quality of the milk of their offspring.

Holsteins have some strong admirers, and Dr. Enrique Fynn, one of the principal breeders of Argentina, is about to make a visit to the

United States to secure some new breeding stock which the laws of Argentina do not permit him to bring from the Continent of Europe. He is well satisfied as to the superiority of the Holstein for his purpose and as a meat producer at the same time. The Holsteins are stronger in the country than any other of the special dairy breeds.

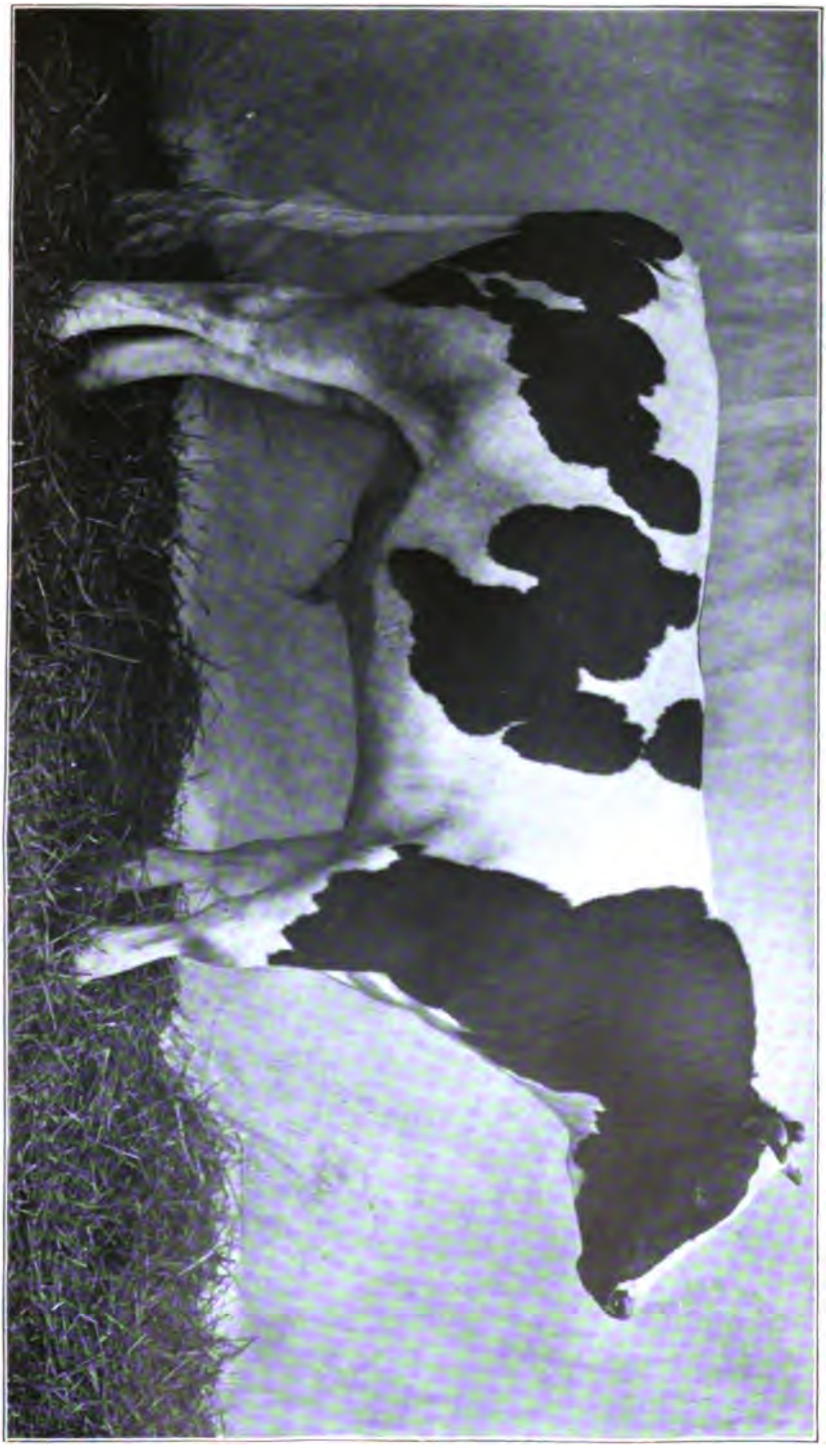
Flemish cattle have been bred for fifteen years on one estancia near Las Heras, about 60 miles southwest of Buenos Aires. One owner has won many prizes with his cattle. He obtained his first stock nearly twenty years ago and has imported a number of well-bred cows from Belgium since. The importation of cattle and sheep from the Continent of Europe to Argentina is prohibited under the agreement with England whereby the English ports were reopened to live animals from Argentina, but such importation had not been permitted for two or three years before. There is no likelihood that European animals will be admitted to Argentina for many years. The supply of Flemish and Holstein breeding stock is very small in the country. There are but two or three herds of each worth mentioning and scarcely any first-class breeding stock is on the market. The strong interest in the dairy industry makes it certain that superior purebred animals of this class which, in addition to their well-known milk-producing powers, show beef qualities at the same time, will find a quick and very satisfactory sale in this market. This applies to Shorthorns as well as to Holstein and Flemish cattle. Tiptop young animals may be relied upon if properly presented to bring anywhere from $800 to $5,000 gold, and $1,500 would seem to be a safe figure to count on. If the animals were of right kind in all particulars they would bring more rather than less if offered at the right time.

One breeder has been trying a cross between Shorthorn and Flemish cattle with significant results. Shorthorn and Shorthorn-Flemish steers of the same age were prepared for market under precisely the same conditions. The Shorthorns averaged 1,218 pounds, while the cross-bred steers gave an average of 1,441 pounds. It is claimed for this cross that it produces a cow almost as good as the Flemish and a steer better than the Flemish and generally as good as the Shorthorn; that the cross-bred steer is hardier than the Shorthorn and matures equally early. The milk test in the recent show also gives some strong evidence favorable to this cross, which now has many advocates and is likely to be tried by others.

But those who believe in producing milch cows by a careful selection of Shorthorns are probably four times as numerous as the supporters of all other breeds combined in Argentina, for no claims are made for the Hereford in this respect

TEST OF DAIRY COWS.

The practical test of dairy cows was one of the most interesting and instructive features of the exposition. The competition was among



DE WET, FIRST-PRIZE HOLSTEIN BULL. 22 MONTHS OLD. SOLD FOR $1,050.

BEST COW OF FLEMISH GROUP, WINNING CHAMPIONSHIP IN DAIRY TEST.

This cow gave 35 liters of milk per day.

lots of 5 cows each. They were given the same food and milk morning and evening for three days under the inspection of the judges. Seven lots of Shorthorns, two of Holsteins, one of Shorthorn-Flemish, and one of Polled Angus were entered. Championship prizes were offered for the group showing the greatest aggregate quantity of milk, quality considered, and for the one showing the greatest percentage of butter fat. All the cows were accompanied by their calves and had, of course, been carefully selected and prepared for this competition, though they had not been allowed to become fat. The result was very gratifying to the advocates of the Flemish and the Shorthorn-Flemish cross. The fact should not be overlooked, however, that the Flemish cows were the result of fifteen or twenty years of careful and intelligent selection from a large herd of the best original Belgian stock and its descendants, while the Holsteins have had only six years of selection from a comparatively small herd.

The Holstein people here feel sure that their breed will furnish a better animal for beef and milk combined, alleging that—

(1) Holsteins are hardier, better adapted to the open life of the Argentine camp, to which they are subjected, than either Shorthorns or Flemish. Holsteins, they say, do better in the open camp than under shelter, requiring the freedom of the open air to produce the best results.

(2) Holsteins are less liable to disease than either Flemish or Shorthorns.

(3) The milking qualities of Holsteins of the same care in breeding and selection are equal to Flemish, and they generally produce better beef animals.

The official report of the milk tests, on which the awards of both championship prizes were made, and others, is as follows, as reduced to our weights and measures:

Record of tests of dairy breeds of cows.

The produce of 5 cows in each lot for three consecutive days.

Breed.	Milk.	Butter fat.	Butter.
	Quarts.	*Per cent.*	*Pounds.*
Flemish	357.12	3.175	25.58
Shorthorn-Flemish	300.63	3.883	26.61
Holsteins	359.86	3.033	22.49
Do	255.72	3.075	17.59
Shorthorns	236.70	3.701	19.86
Do	184.65	3.658	18.47
Do	278.96	3.983	18.47
Do	226.39	3.325	16.91
Do	191.15	3.816	16.71
Do	165.37	3.316	12.26
Do	149.51	3.083	10.36
Polled Angus	210.80	3.400	16.18

SACRIFICE OF COWS.

There is no reliable or complete information as to the number of cows being milked or the number not being milked. No live-stock census has been attempted since 1895, and the best-informed men in the country do not believe there has been much increase in the number of animals since that time, if there has been any increase. So many losses have been incurred, so many cows have been killed, and the younger animals have been drawn upon so heavily for export that the natural increase has been kept down. One estimate, crediting each cow with 30 kilos, or 66.13 pounds, is that only 137,000 cows supplied the export butter trade of 1902. Against this development of a small percentage of the cows of the country, to which should be added those employed in producing butter for home consumption and other milk products, which, all told, can not be more than 1,000,000 and probably fewer, we have some idea of the destruction of cows. In 1902, 96,900 cows were slaughtered in the saladeros, or jerked-beef factories. This was more than three times as many as were consumed there in 1897, when the number was 32,093. In the Buenos Aires slaughter yards 84,902 cows were killed for beef in 1901, and in 1902 the number was 109,890. The same thing is going on all over the country. To be sure, the cows slaughtered are the inferior ones, but by no means old ones only. It suits the men who are improving their stock to get rid of the poorer cows to the best advantage, and that is for slaughter.

"But it is a bad thing for the country to have so many cows killed," says Ronaldo Tidblom, director of the bureau of animal industry. "The better class of estancieros, those having valuable camps, may not find it to their advantage to keep these cows, but they are needed outside on lands not so valuable, where any cow is better than no cow. For the interests of the country at large, we can not afford to have so many young cows slaughtered, and measures will be taken to prevent the killing of cows under 5 or 6 years old. We would like to say 7 years, but that is impracticable, because it is difficult to keep account of the age of cows after they have all their teeth. So the best we can do is to prohibit the killing of cows before they have all their teeth and are known to be 5 or 6 years old. Then we hope the surplus cows of the inside camps will find their way outside, where they are needed. This subject will be discussed in congress this winter and something will be done."

STATISTICS OF PRODUCTION AND CAPACITY.

The dairy industry is not yet sufficiently organized to permit one to say what it costs to produce a pound of butter, or what the average yield of milk per cow is, or what cows are worth. These things can only be approximated. It is safe to say that the average estancia cow does not average much more than 5 or perhaps 5½ quarts per day, and that this milk will not test on the average through the year more than 2.8 to 3 per cent butter fat; in many cases it will be more, and in the fall—in April and May—the percentage of butter fat will rise considerably. Some herds will average 3 per cent or a trifle more, but 3 per cent the year around is considered good. As to yield in quantity, many cows will not give more than 4 or 4½ quarts per day, while others will give much more. The following estimate is given by the Rural Society in its annual report, the information having been furnished by La Union Argentina:

> To produce a pound of butter, 10 English quarts (equal to 12 United States quarts) or about 25 pounds of milk are required. The cows in our dairies and estancias, a cross of Shorthorn and criolla (the native half-wild stock) will yield about 5½ quarts per day, remaining in milk for about 210 days. It must be remembered that in all dairy herds there are always about 30 per cent of the cows that can not be milked for one reason or another.
>
> The average cost of a dairy cow and calf is about $30 (United States); if the yield is greater than the average of 5½ quarts, the cost is proportionately higher, as it is considered that each additional quart of milk yield represents an additional value of about $5 gold; so a cow giving 9 quarts is worth from $45 to $50, and if it gives from 13 to 15 quarts, $65 to $76. About 90 per cent of our dairy cows are graded Shorthorns. Three cows with their calves require about two squares (8¾ acres) of land. Rent of land is about $1.50 gold per acre per year. Care and milking in each dairy (120 to 150 cows) requires three experienced men. The wages of these men would be a little over $15 gold per month, with board and lodging, which represents about $8 gold in addition. The price paid for milk by the creameries is about 1½ cents gold per quart.

The prices here given for cows are rarely realized except for the very best class of graded Shorthorns—known to have good blood. The average cow sells for half or less than half the amount quoted. The rental price for land is low except for land far out in the outside camps.

At present the business is confined to the northern two-thirds of the province of Buenos Aires, southern and eastern Córdoba, and most of Santa Fé and Entre Rios, except the northern parts, where it is too hot. The development of dairying is not only increasing with great rapidity in that territory, but is going beyond it, especially to the south and west, so it seems safe to count on seeing several million more cows being milked in two or three years and a consequent enormous increase in the exportation of butter from Argentina.

In the dry times and in the spring when the grass is watery the tests for butter fat run very low. One of the oldest and best herds of beef Shorthorns has had cows giving at these times as low as 1.7 to 1.8 per cent. Reliable creamery tests through the year gave this herd but 2.31 per cent butter fat on about 300 cows—a very low average. In the same vicinity another herd, consisting of Shorthorns, grade Shorthorns, and a slight strain of Jersey in some animals, averaged 3.22 per cent of butter fat, which is above the general average for that section of the country. A herd of Jerseys belonging to the creamery, of which 250 are always being milked, gives 4.36 per cent of butter fat. All these tests cover a period of twenty-two months, four composite tests being made each month. The locality was Carcarañá, province of Santa Fé, near Rosario, and the period included a very serious drought, during which the cows suffered much. Some of them were fed a little dry alfalfa during the worst time. The creamery herd of Jerseys is fed nothing but a handful of chopped alfalfa and bran at milking time to keep them quiet. During this period of twenty-two months the Jerseys on alfalfa averaged 6½ liters daily, though this is far from a fair indication of what they do there, because of the drought and short pasturage. Many individuals in this herd give 20 liters a day when in full flow and test 6 per cent butter fat—sometimes as high as 6.8 per cent. The Jersey calves are taken from their mothers as soon as they are born, and most of the bulls are sold as soon as possible for veal. Though they are very well bred, and in the United States would be valuable for breeding animals, there is no demand for them there. The Jersey is a very unpopular breed in Argentina because it gives so little beef, and, though occasionally a rich estanciero or breeder has a few Jerseys for his own family use, they are regarded as an expensive luxury. The Carcarañá people raised a few steers from their Jerseys for their own use and found the beef good, though the animals were small.

CHEESE BUSINESS NOT SATISFACTORY.

The Carcarañá creamery is managed by an American and is one of the oldest in the country, having until recently a very profitable, almost monopolistic, business in cheese. The Carcarañá cheese is famous all over the country. The factory was started many years ago by a citizen of the United States, who died about two years ago. At first it was a butter factory, but the cheese business, once the conditions peculiar to the country were mastered, was very profitable until others began to follow them into the industry, which resulted in overstocking the limited Argentine market with various sorts of cheese. The overproduction reduced the price one-third; now it is only about 80 cents paper per kilo, or about 16 cents gold per pound. They tried to export, but lost money in the South African market.

The Carcarcañá cheese is a rich full-cream cheese of excellent quality, but, like all other cheese made in Argentina, its sale is and will for some time be limited. The cheese industry in the country is more or less in this condition generally and is not very prosperous; therefore attention is turned chiefly to butter.

EXPERIMENTS IN COMPARISON OF BREEDS.

An experiment recently made on the Grañja Blanca estancia, near Las Heras, 60 miles southwest of Buenos Aires, gives a reliable record and comparison of four lots of cows—two of Shorthorns, one of Flemish, and one of Holsteins—covering an entire year. The following table gives the result in United States quarts:

Milk yield and percentage of butter fat in cows of different breeds.

Year and month.	Herd No. 1, 170 Shorthorns.		Herd No. 2, 170 Flemish.		Herd No. 3, 130 Holsteins.		Herd No. 4, 170 Shorthorns.	
	Quarts.	Percentage of butter fat.	Quarts.	Percentage of butter fat.	Quarts.	Percentage of butter fat.	Quarts.	Percentage of butter fat.
1901.								
July	18,927	3.7	17,964	3.2	10,908	3.0	17,355	3.1
August	22,173	3.7	13,758	3.3	17,769	3.4	19,368	3.3
September	20,302	3.4	19,243	2.6	14,122	3.4	17,966	3.0
October	22,847	2.9	22,736	2.6	17,030	2.6	20,483	2.9
November	30,411	3.1	30,594	2.4	15,202	2.7	32,536	2.8
December	33,955	2.8	31,669	2.6	21,633	2.7	42,479	2.8
1902.								
January	34,574	3.4	31,173	2.9	24,917	3.1	48,376	3.1
February	34,942	3.5	30,181	2.7	22,620	3.0	42,226	3.1
March	28,916	3.8	30,560	3.2	20,365	3.3	33,815	3.4
April	26,397	4.3	30,266	3.2	13,743	3.6	27,063	3.6
May	19,047	4.3	27,419	3.3	13,093	3.6	17,689	3.7
June	17,662	3.8	25,382	3.1	12,336	3.5	13,959	3.1
Total	310,153	....	310,945	....	203,738	....	333,315	....
Average	....	3.6	....	2.9	....	3.2	....	3.2

Condensed statement.

Breed.	Total production.		Production per cow.		Average of butter fat.
	Per year.	Per day.	Per year.	Per day.	
	Quarts.	*Quarts.*	*Quarts.*	*Quarts.*	*Per cent.*
No. 1, 170 Shorthorns	310,152	850	1,824	5	3.5
No. 2, 170 Flemish	310,945	852	1,828	5	2.9
No. 3, 130 Holsteins	203,737	558	1,567	4	3.2
No. 4, 170 Shorthorns	333,316	913	1,960	5	3.2

The Shorthorns have been going through a process of selection for eleven years, especially herd No. 1, showing a little better results than herd No. 4. The Flemish cows were bought only two years before and were not selected animals; many were only heifers, so the comparison is hardly fair to them. The Holsteins have been on the place six years and included practically the entire herd of this breed, both inferior and superior. The Gerber test was used to determine the percentage of butter fat in the milk. These averages are considered very good, running through the year, of cows kept all the time in the open camp. Another test near Buenos Aires, of which careful record was kept every day for ten years, for each individual cow in a herd of 200 grade Shorthorns, nearly pure, shows a steady average of 3 to 3.5 per cent of butter fat through the year. These cows were in the open camp, on natural grasses, with perhaps a little dry alfalfa in the winter.

HOW COWS ARE FED.

The cows in the Grañja Blanca experiment were given no dry feed, except occasionally a little dry alfalfa, when the pasture was dry in the winter; but this is done only by a small minority of estancieros. Most cattle—and, indeed, these cows most of the time—live and fatten and the cows give rich milk the year around on the native grasses and nothing more. They do not have so much alfalfa in this part of the country as in others, as it does not do well. Alfalfa in this section lasts only seven years at best, and if cattle are put on it, only two years, as a rule. But the native grasses are very rich and, in ordinary times, furnish abundant feed through the year. There are winter grasses and summer grasses, succeeding each other, so that there is always fresh grass; and, unless a drought occurs, there is never need of giving dry feed, even to fatten steers. The estimate put upon the carrying capacity of the native grasses in this district is 2 cattle per square (4.17 acres) the year around, or 1 per square for fattening. In the spring and summer the camps will carry more, especially the so-called refined camps, that have been in use for some years with cattle and not overstocked, so the better grasses predominate. But if pastures are stocked to the limit in the summer they will not be in condition to carry the cattle in the winter.

Not only the wild native grasses, but several of the tame grasses and forage plants well known in Europe, which it is declared have never been artificially planted here, are to be found in these refined[a] camps.

Among them are white clover, rye grass, and timothy, all of which I have seen growing on Buenos Aires estancias, where people insist that it has never been planted. There are several others of these grasses that appear and flourish at different times in the year.

The thistles of Argentina were once considered one of the most valuable cattle foods, and in all the camps that are without alfalfa they are yet highly valued, and often come in very opportunely when other pastos, or grasses, are not at their best, especially in winter. In fact, it was with serious hesitation that estancieros began to destroy the thistles in order to put in alfalfa. The pioneers in alfalfa began more than twenty years ago, and among the earliest and most prominent of them were the Benitz Brothers, from California, on their estancia "La California," about 70 miles northwest from Rosario, the second city and produce market of Argentina. They were the first to have a league of land in alfalfa. When they began they were warned by the natives of the folly of plowing up the thistles, and were assured that they would suffer for it, but their success has proved that they were right.

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[a] A refined camp is a portion of the country better developed than others.

But the usefulness of the thistle is not entirely past. The three principal varieties that mark the "refinement" of the camp are cardo negro, or black thistle, the first to appear; cardo de castilla, or Spanish thistle, which follows in two or three years; and cardo asnal, or coarse thistle, the last to appear, after the camp has been in process of "refinement" for several years. The last is the best for cattle and is considered a valuable forage plant in some sections where there is no alfalfa. It is green in the winter, even in dry times, and the cattle like it.

CARRYING CAPACITY OF PASTURES.

The carrying capacity of an Argentine camp varies so widely from the rich alfalfares, or alfalfa pastures, and inside natural camps to the more or less barren outside camps that it is impossible to say what the country at large will do. Director Tidblom makes an estimate of 1 bovine animal to 6 acres and 1 sheep to 1 acre. This applies to the distant pampas, where the grasses are not so rich and the water is scarce, but it does not apply to the sections in which cattle are fattened, or where they will be fattened for a good many years. Regions like that will produce stock cattle to be fattened on richer pasturage, nearer market. In the province of Córdoba, for instance, the natural grass, or pasto fuerte, as it is called, will carry about 800 animals per league, or 1 to 8 acres, but they do not get fat by any means. On the same land put into alfalfa 3,000 head of cattle are kept fat the year around. The land is divided into several poteros, or pastures, and the cattle are moved about from one to another of these. There are plenty of places in the country where the same conditions prevail, and they are fast being made over into alfalfares. Many landowners are gradually working their land into alfalfa by colonizing it and thus earning enough from wheat or flax in the first two or three years to pay all the expense of putting it into alfalfa, which the owners could not afford to do at once, and this system gives them a profit besides. On the other hand, many estancieros in the south and middle of the province of Buenos Aires are finding it so profitable to raise wheat that they are renting their land to colonists for wheat or are putting it in themselves, rather than use it for stock. In other parts of the same province they say that 1 to 1¼ animals per square (4.17 acres) is the capacity of the native grasses. In the same place the estimate of the alfalfares is 3 animals per square for six to seven months out of the year, as in winter there is not much alfalfa to be had. In the province of Santa Fé the native camps vary widely, but in the southern part, which is best, the native grasses can be relied on in good seasons for about 1 to 1¼ animals per square; but when the dry cold season comes on, the cattle do not do well on this feed. Alfalfa in the same district will fatten 3 to 5 head per square in five to eight months, depending on the condition of the cattle when they reach the place, and the nature of the season—whether the alfalfa is in prime condition or needing rain. In the province of Buenos Aires, where they have alfalfa, it usually does not endure feeding well, except in certain exceptional parts. The native grasses are more relied upon, as they are much better there than in the upper provinces. In Córdoba and Santa Fé they are forced to put in alfalfa, as otherwise the camps would not be stocked, except with inferior criolla, or native, cattle.

As a general rule, in the majority of cases, little or no provision is made by estancieros against the usual annual dry season in the winter or for extreme droughts, and the cattle suffer accordingly. Of course, there are many exceptions to this improvidence, notably in the older and more valuable inside camps, and the success attained by the men who have taken the better care of their stock during the cold and dry seasons have done much to teach the necessity and profit of preparing to give stock dry feed during times of drought, and to finish steers on grain. Cheap, frozen, grass-fed beef will, of course, continue to be sold in England, but for export alive and for chilled beef of the best quality, alfalfa or the native grasses alone will not produce animals that will command high prices.

ADVICE OF AN ARGENTINE PACKER.

Mr. Daniel Kingsland, manager of the new chilled-meat works in La Plata, near Buenos Aires, has just issued a circular to estancieros giving them advice as to the best kind of animals to meet the demands of the chilled-meat trade. His suggestions have added importance from the fact that he is an old resident of the country, a producer of beef animals himself, and knows the conditions and possibilities of the country well. In his circular he says:

With regard to cattle, the export of beef in a refrigerated or chilled state to the United Kingdom is now an accomplished fact, but is still in its infancy, and places this country in the position of being the principal competitor of the United States of North America, which has hitherto enjoyed the whole of this trade. To compete with them successfully, it is our opinion that great care should be taken to produce bullocks which will always be worth more for this purpose and command a higher price than for any other. For chilling, it is not necessary to send extremely heavy-weight cattle. Bullocks of two and a half to three years old, well finished, and weighing from 550 to 620 kilos, or an average weight of 580 kilos (1,213 to 1,367 pounds, or an average of 1,278 pounds), will command the best prices. To produce this article from the average well-bred mestizo (graded animal), now plentiful, it does not matter whether the cross is Durham, Polled Angus, Hereford, Red Lincoln, or any other meat-producing strain, so long as the animals are always well fed and looked after in the winter season, when grass is scarce, or any other time when there should be a shortage of feed, never allowing the animals to become poor. This can be done by always growing a certain amount of alfalfa, corn, or other foods for winter

Grade Shorthorn Bulls, 2½ Years Old, Second-prize Lot. Sold at an Average of $1,731.

HOLSTEIN COWS AND CALVES. PRIZE WINNERS IN THE DAIRY TEST.

feeding. By doing this estancieros will have no difficulty in producing the animals required all the year around, and the results will be satisfactory to themselves. The trouble and expense of cultivating a small proportion of their land in order to provide food for the winter and fattening stock in bad seasons will be well repaid.

Concerning the production of lambs for export, Mr. Kingsland says:

> The production of lambs for export shows the greatest room for improvement, and should give good results to those who undertake to produce the suitable article. This can be done by introducing meat-producing strains of sheep into your flocks, such as Hampshire, Southdown, Oxford, Shropshire, and also Border Leicester rams, and, for the low camps, Romney Marsh rams. Then by winter feeding the ewes, enabling them always to have plenty of milk for their lambs, they would fatten at from five to seven months old to average 30 kilos (66 pounds) live weight, and would be worth 10s., or even more. Lambs intended for export should never be shorn, as it throws them back, and the wool obtained barely covers the cost of shearing. By producing lambs and selling them at this age, you are turning your capital every year, and therefore doubling your producing powers. The following facts will show you how far we are behind New Zealand, which country is our chief competitor in the frozen-sheep industry: The total number of sheep of all classes in New Zealand last year was about 20,000,000, and it exported nearly 4,000,000 of frozen sheep and lambs. At the same time we had 100,000,000 sheep in this country and our export was only 3,500,000. These figures speak for themselves, and should be an object lesson as to the possibilities in the production and early maturing of fat lambs; and it has also had the effect of increasing the value of, and extending the demand for, land suitable for the production of lambs to a very great extent. We would strongly advise estancieros to lay themselves out to prepare a certain number of lambs for export every year. The results must be of the most satisfactory nature to them and will increase the value of the flocks and camps all around.

LIVE STOCK CENSUS.

No one knows how many cattle there are in Argentina. Authorities disagree in their estimates, but it is now quite generally admitted that the estimates that have been given during the past two or three years are too high. The last regular live-stock census, taken in 1895, compared with the previous one, taken in 1888, is as follows:

Live-stock census of Argentina, 1888 and 1895.

Kind of animals.	1888.	1895.
CATTLE.	*Number,*	*Number.*
Criollos (native)	17,574,572	14,197,159
Mestizos (graded)	3,388,801	4,678,348
Purebreds	37,858	72,216
Milch cows	960,426	1,800,799
Oxen for service		953,004
Total	21,961,657	21,701,526
HORSES.		
Work horses	1,043,379	4,016,297
Criollos (native)	2,926,687	
Mestizos (graded)	259,009	414,985
Thoroughbreds	4,957	15,577
Total	4,234,032	4,446,859
SHEEP.	*Number.*	*Number.*
Criollos (native)	24,322,214	17,938,061
Mestizos (graded)	42,002,871	56,106,187
Purebreds	381,012	335,314
Total	66,706,097	74,379,562
Total live stock:		
Cattle	21,961,657	21,701,526
Horses	4,234,032	4,446,859
Sheep	66,706,097	74,379,562
Pigs	393,758	652,766
Asses and mules	417,494	483,369
Goats	1,894,386	2,748,860

Statistics just published by the bureau of statistics of the department of agriculture, covering about three-fourths of the country, show that where in 1895 there were 16,256,363 cattle, there are now only 15,446,852, a decrease of 5 per cent. The correctness of these figures has been challenged, and the bureau of animal industry is arranging to take a census that will be more reliable. Still, it is well known that there is a much less number of cattle in some parts of the country, notably in the southwest and in the north. Droughts, overstocking, garrapata ticks, foot-and-mouth disease, and anthrax have carried off many thousands. Cows have been sacrificed, thus interfering with the natural increase, until the Government is planning, as previously explained, to take steps to stop it. Younger animals are being sent to market also. The most conservative estimates do not place the total number of cattle in the country at more than 24,000,000, though it must be admitted that it is most difficult to arrive at a safe estimate or to find a sure basis to figure on.

Estimates on the number of sheep, based on the amount of the clip, on known conditions, careful reports from the sheep sections, and intimate knowledge of the business, vary from 80,000,000 to 115,000,000. It is probably fair to conclude that the real number is a little below an average between these two figures.

EXPORTATION OF LIVE STOCK.

During January, February, March, and April, when the English ports were open to Argentine live stock, the number of animals exported was:

Exports of live stock from Argentina, January to April, 1903.

	Cattle.	Sheep.	Horses.	Mules.	Asses.
January and February (chiefly to England, South Africa, Brazil, and Spain)[a]	11,926	48,663	1,234	7,388	5,597
March:					
To England	10,319	29,203	34	....	....
To South Africa	959	12,880	150	74	20
To other countries[b]	264	3	27	....	....
Total	11,542	42,086	211	74	20
April	12,877	44,105	529	997	30

[a] English ports open to Argentine live stock February 3 and closed May 9, 1903.

[b] The actual totals for March from revised returns were: Cattle, 13,594; sheep, 47,931; horses, 626; mules, 89; asses, 30. Destinations are not given.

The average weight of the steers exported is given at 1,462 pounds.

Considerable complaint has been made by the exporters of live stock about the delays and expense of the inspection, disinfection, and fittings required by the Government for the exportation of live stock. But no doubt these will be overcome in time. The Government appears determined to use all possible precautions to prevent diseased animals from being exported and to provide that the animals shall have such care on the voyage as that they shall arrive at their destination in good condition.

The results were not what had been expected, for various reasons. A great majority of the cattle that did not do well on the voyage were wild, untamed brutes. They were bruised and frightened in the railway cars coming to Buenos Aires. Arriving there, they were unaccustomed to such close quarters, did not know how to eat dry food, and, being hustled about and lifted on board in great cages high in the air, they were still more frightened. On board they knew still less how to adjust themselves to their new surroundings, failed to eat, were probably not so well cared for as they might have been, and some very heavy losses resulted. One ship was out twenty days longer than expected, and the animals had little to eat. Several lost from 20 to 30 per cent of the animals on board, and those that got through were in bad condition. The sales ran from £12 to £23 ($58.32 to $111.78 U. S.) in the English markets. Several cargoes were sold at £12 to £16 ($58.32 to $77.76 U. S.), which meant heavy losses. The animals cost in Argentina from £8 to £11 ($40.88 to $53.46 U. S.), generally about £10 ($48.60 U. S.). The ocean freight was from £3 10s. to £4 10s. ($16.91 to $21.87 U. S.), the former being the lowest rate at the time the ports were closed (May 9). The rates for sheep were 6s. a head. Then there was the cost of feed and care besides, so that £18 ($87.48 U. S.) was the lowest price that gave a profit. Rates to South Africa were £4 ($19.44 U. S.) for cattle and 6s. ($1.44 U. S.) for sheep. To Para, Brazil, where a small but regular trade in cattle has been worked up, the rate is £4 10s. ($21.87 U. S.) per head. The ships used in the trade are not specially adapted to the business. There was lack of proper ventilation, the fittings were not always what they should have been, and, in fact, the business was just being learned and better ships were being offered when the foot-and-mouth outbreak put a stop to it for a time.

But the chief lesson learned by Argentines in their latest experiment with cattle exportation was that they must abandon their hopes of getting prices equal to those obtained for the prime corn-fed steers from the United States unless they also feed their animals grain to finish them for market. They also learned that a wild animal will not come off the range, take a railway journey, and go on shipboard and travel four weeks unless he has been prepared for it by taming and feeding before he leaves the estancia. So we may expect to see the Argentine estancieros begin within a year or two to put grain-fed steers on the market, but not in large numbers.

HEALTH OF LIVE STOCK.

Aside from the anthrax, which is still very bad in the province of Entre Rios and in certain parts of the province of Buenos Aires, and the garrapata, or Texas fever ticks, which infest the northern provinces, the health of the cattle is good. The foot-and-mouth disease, referred to elsewhere, is regarded as a very small affair that will soon be ended so far as the better part of the country is concerned. The past season and the present one have been favorable to the health of cattle, except in a few places, where they have suffered from severe droughts. The Government is making a brave effort to confine the ticks to the warmer sections, where they are thickest, and to prohibit cattle from coming south beyond a certain point.

For many years cattle have been brought down from the Chaco and other parts of northern Argentina to be fattened on the rich camps of the provinces of southern Santa Fé, Córdoba, Entre Rios, and northern Buenos Aires. It has been a very good business, for the producers of stock cattle on these cheap northern camps could afford to sell their stock at very low prices. The cattle were immune from the fever, though carrying plenty of ticks. In this way some of the best stock regions were infested with ticks. But those who brought these cattle down, paying $15 or $20 for 2-year-olds, keeping them on grass for a year or so, and selling them at prices ranging from $35 to $60, strongly objected to having this business interfered with. The question was discussed for several years before the Government finally established a line and required the cattle crossing it coming south to be dipped. It was made compulsory to use a certain dip, and that was another source of controversy, the claim being made that other dips were equally good. But the Government authorities insist that their dip is the only one that will actually kill the ticks, while other dips simply cause them to drop off the animals. The establishment of this line affected the saladeros, or jerked-beef factories, the shipment of fat steers to Buenos Aires, and the bringing of steers down from the north to fatten. In the province of Entre Rios, where the saladeros are located, the movement of live stock furnished a large part of the provincial revenues, and its partial curtailment inflicted hardship on the provincial government. It is generally claimed that the official dipping stations are wholly inadequate. The animals are submerged one at a time in a cage let into the bath by a sort of derrick. It is impossible to dip more than 200 or 250 per day of these wild animals. All sorts of objections were and are still being raised. Besides, many stockmen regard the whole thing as nonsense and claim that the ticks do not carry the Texas fever. Several postponements of the taking effect of the decree were made, but it finally went into operation on April 1, 1903. During that month it was suspended, so far as Entre Rios was concerned, until July 31, under an agreement with the provincial government that it would cooperate with the Federal Government at the end of that time in putting it into full force. The provincial government is to erect enough dipping stations to accommodate the demands. The Minister of Agriculture has just refused to further extend the time when dipping will be required.

THE SHEEP BUSINESS.

During the first six months of the year 1902, and in the latter part of 1901, the sheep business in Argentina was very discouraging and the Argentines, always quick to take up a promising new thing and just as quick to run from it when they strike a bad season, began to sell their sheep for nearly nothing. Sheep could be bought by thousands for $1.50 to $2 and many were sold for $1 paper, or from 45 to 90 cents gold each. Various causes contributed to this, but the low prices of wool and mutton were the chief ones. The British ports were closed to live sheep and the freezing companies paid what they pleased for fat wethers and lambs—usually from $4 to $6 paper, rarely more than $5.50. The best wools were selling at 15 to 20 per cent less than now. The home demand for mutton was not sufficient to make a price better than $2 to $4 in Buenos Aires. The coarse Lincoln wools especially were not in demand and were being shipped in great quantities to the United States for carpet manufacture. Now the markets are better for both wool and mutton and a change is coming over the Argentine flocks. This was one of the most striking features of the great annual show, and it points to conditions that offer to the sheep breeders of the United States an opportunity to make some sales of Rambouillet and Merino rams. Of the 1,718 sheep exhibited and offered for sale, 955 were Lincolns, but they did not, as heretofore, bring the highest prices or command the most interest. The Down breeds, the Rambouillets, and the Merinos were more sought after, in proportion to their numbers, and their numbers were greater than in any previous show. It will be noticed that the Lincolns stood third in the average price of sale, closely pressed by the Oxford Downs. The prices were not so high as in 1901, when the champion Rambouillet ram sold for $7,300, and this year it sold for only $2,000. But the highest priced Lincoln was only $1,600. In a later sale in January a group of 4 Lincolns sold for an average of $1,750, the highest price being $2,300.

In this sale (January 21, 22, and 23) 383 rams, mostly shearlings, from 16 to 28 months old, were sold with the following results:

	Average price.
267 Lincoln rams, purebred	$206.53
75 Lincoln, grades	46.13
41 Black-faced purebred rams	121.27

Highest and lowest prices of principal breeders.

Breed.	Owner.	Number sold.	Highest.	Lowest.	Average.
Lincolns	Puchuri & Co	4	$2,300	$1,300	$1,750
	Mendiberri	5	770	340	474
	Espartillar	20	1,200	170	292
	Cec. Lopez	7	600	150	391
	Manuel José Cobo	4	500	320	380
	B. Gimenez Paz	8	480	170	243
Hampshires	Hector F. Casares		200	100	
Oxford Downs	Leonardo Pereyra		320	200	
Shropshires			160	100	

With the exception of the Puchuri and Mendiberri lots, these were the second picking of the flocks, the best having been sent to the Palermo show the previous September. These two breeders did not exhibit at Palermo. With these exceptions the animals were, on the whole, inferior to those shown at Palermo, especially the Downs. The following is from the manager of the largest live-stock auction house, whose opportunities for studying the needs of Argentine breeders are unsurpassed:

> In my opinion this year's tendency has been toward the Black-faced sheep, the Downs, a tendency which is likely to grow until the breed impresses itself upon the country over the Lincolns and Rambouillets, just as in former years the Lincolns imposed themselves against the Merino types. The reasons for this are early maturity, hardy constitution, quality of meat, and equal price for wool. These are the same conditions which in other times secured superiority for the Lincolns, a superiority which has commenced to vanish on account of the excess of production. I attribute this evolution of breeds less to a distinct superiority of any of them than to the influence—the inexorable law—of supply and demand upon production. Experience in breeding, combined with a clear insight into the special requirements of camp and climate for each of the improved breeds, will bring forward the good qualities they all possess.

The objection of the exporters to the big Lincoln, both on the hoof and as frozen mutton, has had a great influence upon the breeding of a better mutton, one that gives a smaller, firmer, leaner meat. The overproduction of the coarse Lincoln wool was the other strong influence, although this season there has been some improvement in the price of Lincoln cross wool. The opinion is quite general in the country that the breeding of Lincolns has gone too far, and that a better mutton and a finer wool must be produced. So the Downs, the Blackfaces, are being sought for, especially the Oxford Downs, and also the Shropshires. The demand for Rambouillets is still strong. As it is now forbidden to bring rams or any other live stock from Germany or any other part of the Continent of Europe, and as the Merino types are again being sought after, it is plain that this is the time for our breeders to send their best animals to this country, just as they did many years ago, when the first Merinos were brought to Argentina from Vermont.

Several hundred Lincoln rams have already been imported from England, and are being, or have been, sold at auction. The prices were very good, one lot of 20 rams and 10 lambs averaging $908 each for the rams and $302 for the lambs. Another lot of 6 averaged $1,175; one sold for $3,000. Ten ram lambs averaged $237. Another lot of 4 averaged $314. Among the arrivals from England were 54 Shropshire rams and 62 Shropshire ewes; also 15 Hampshire Down rams, upon order. This breed is quite extensively used in Argentina.

The Shropshires brought only about $250 paper each at the first sale, and a second sale only $100 to $160. The demand was quickly supplied.

The freezing works pay a higher price per pound of dressed meat for the smaller, finer mutton sheep than for the coarse, large Lincolns, because the latter meet with objections in the English market, where for several years they have sold for a lower price than the smaller carcasses. One of the largest frozen-meat concerns in the country grades its lambs and muttons into the following five classes: No. 1, 34 to 39 pounds; No. 2, 40 to 48 pounds; No. 3, 49 to 56 pounds; No. 4, 57 to 64 pounds; No. 5, 65 to 72 pounds.

The 50 to 56 pound carcasses are preferred, so the sheep that will dress nearest to that weight and furnish a good quality of mutton is the one that commands the highest price. The opening of the English ports is, of course, emphasizing this preference for the smaller mutton sheep, creating a much larger demand for the wethers. This will encourage the breeders of the Downs, the Merino types, the sheep of smaller, finer carcasses and finer but lesser weight of wool. Still, the improvement in prices of Lincoln and Lincoln cross wools this year has encouraged the Lincoln breeders, already so greatly in the majority; and Lincoln rams are still in strong demand, as shown by the successful sales of those recently imported from England.

The sheep market in the suburbs of Buenos Aires is a great national institution, under private management and well directed. Here most of the sheep in the Republic are sold, although many are sold on the estancia, much the same as cattle—that is, the better class of export lambs and muttons. Prices vary greatly, according to the quality and weight of the animals, the amount of wool they carry, the demands of the market at the time of purchase, the distance from Buenos Aires, etc. All sheep are bought by the head, as are cattle.

The price of the export type of mutton sheep has been going up for several months, more noticeably since the opening of the English ports to Argentine live sheep. The top price now is $12 per head for the best export wethers. The daily prices in the Buenos Aires market range from $6 to $12 for fairly good animals, though many are sold for less. They are inferior animals, however. All the really good ones bring from $8.50 to $11.50. These prices are about double those of a year ago. The higher prices are for the product of well-known estancias, in large numbers, where the animals are more uniform and of exceptional quality. The prices vary from 11 to 16 cents paper per kilogram live weight, the average at this time being about 15 cents. This is equivalent to a range of $2.18 to $3.20, or an average of $2.97 gold per 100 pounds. The distinction made by the frigorificos is that they pay more for the small sheep of fine mutton than would be warranted if size only was the consideration, as compared with the price paid for the big Lincolns. The latter, however, give a greater quantity of wool, and, though the mutton price in England is lower, there are more pounds to sell, so the man who raises it can afford to take a lower price per pound. For these reasons, although the Lincoln will stand less hardship than the smaller breeds, his champions in Argentina are not deserting him altogether.

THE EVOLUTION OF THE SHEEP-BREEDING INDUSTRY IN ARGENTINA.

There is no better authority on sheep breeding in Argentina than Mr. Herbert Gibson, vice-president of the National Rural Society. His father before him was a sheep-breeder there also, and his interests are chiefly concerned with sheep, as importer of purebred rams, breeder of breeding stock for this country, producer and purchaser of wool, and producer of mutton. A few years ago he published a book, "The History of the Sheep-breeding Industry in the Argentine Republic," and it is considered an authority to-day, except as subsequent developments have changed the conditions in the country. Mr. Gibson was most active and prominent in the introduction of the heavy, long-wooled Lincolns into the country twenty years ago, and urged the crossing of the Lincoln on the smaller Merino breeds for the double purpose of producing the greatest quantity of wool and mutton.

For these reasons importance must be attached to the recent publication of an article in the Anales de la Sociedad Rural Argentina, the official organ of the Argentine Rural Society, by Mr. Gibson, in which he distinctly modifies his views regarding the Lincoln breed. The fact that this article, written by the best-known writer on the sheep industry and one of the foremost advocates of the Lincoln, appeared in the chief agricultural and pastoral publication in the country, is the best evidence to be had of the great change that is now taking place in the sheep industry of Argentina. The article will be found to be of the deepest interest by all who in any way deal in mutton or wool, for it is based on long and thorough study and experience and is the verdict of a man completely convinced against his will, who

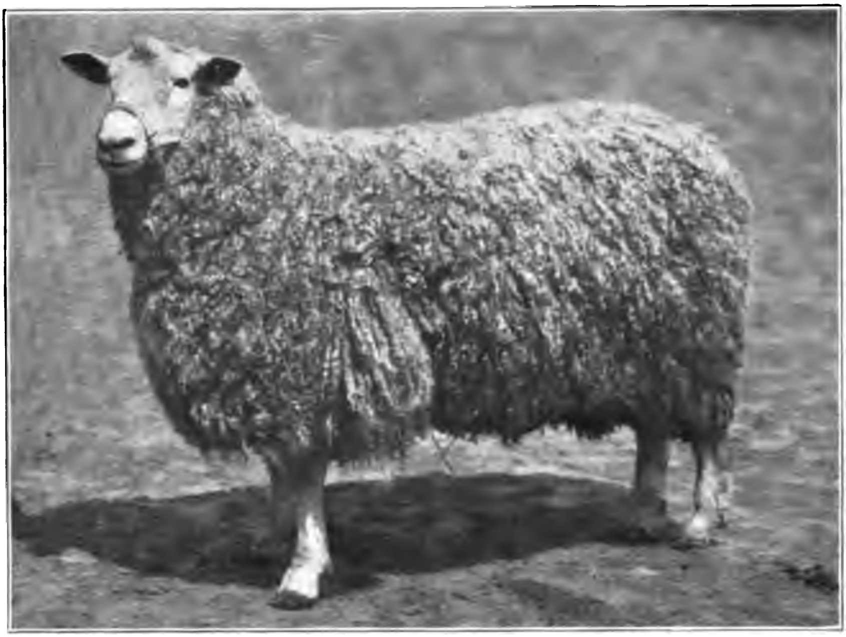


FIG. 1.—FIRST-PRIZE YEARLING LINCOLN SHEEP. SOLD FOR $1,350.

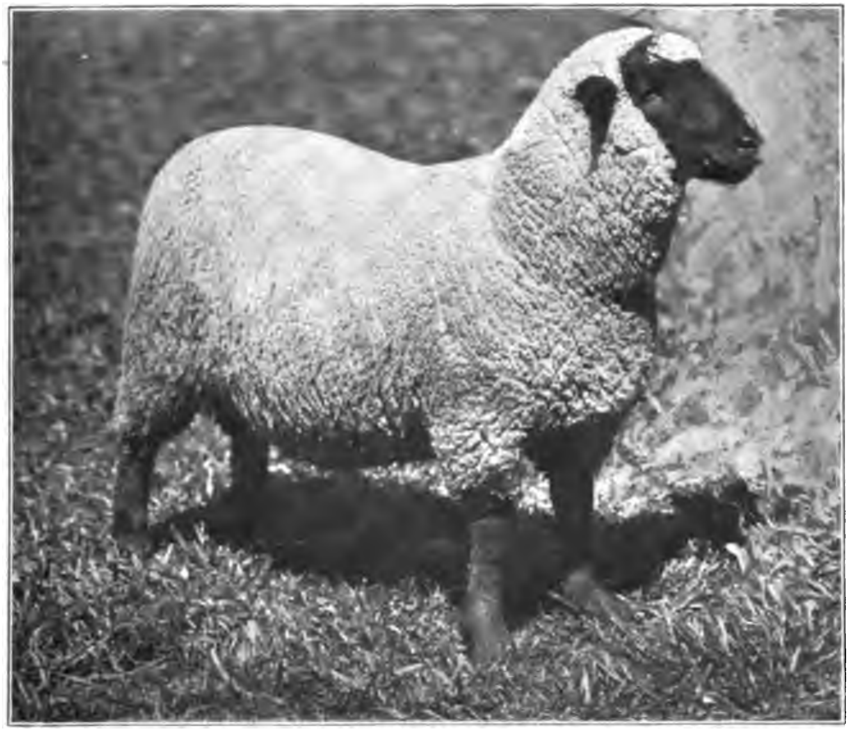
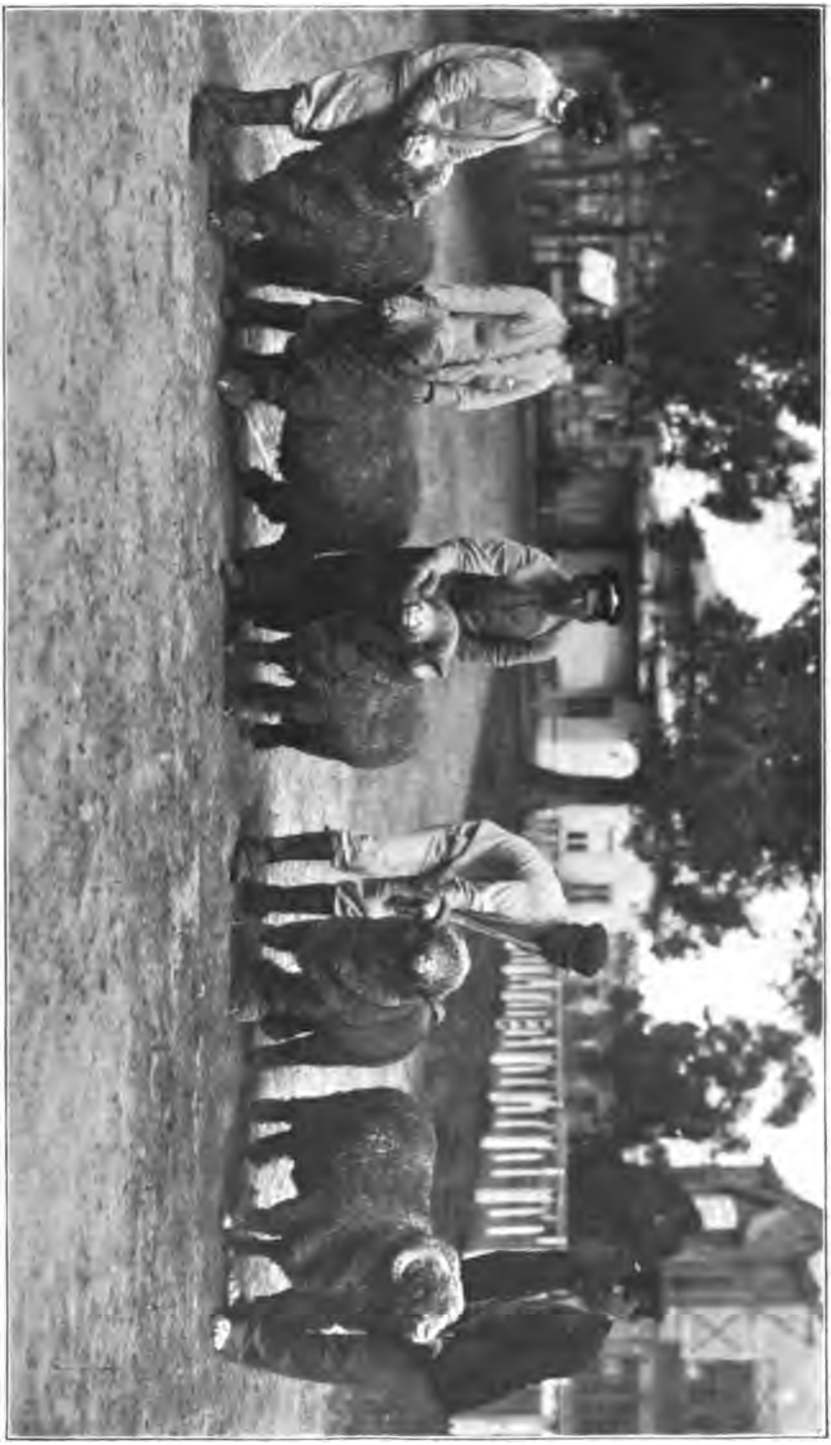
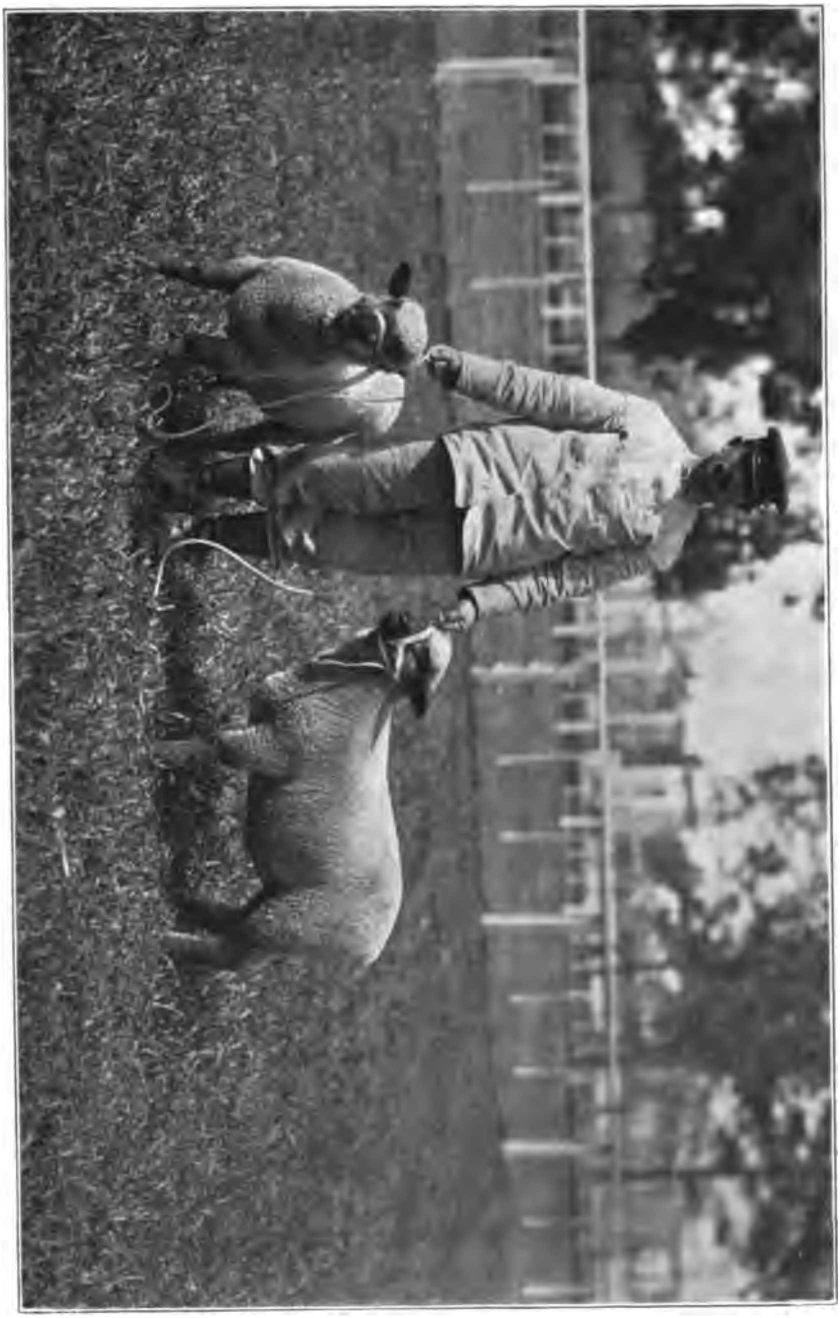


FIG. 2.—FIRST-PRIZE HAMPSHIRE DOWN RAM.



SECOND-PRIZE RAMBOUILLETS, 18 MONTHS OLD. THREE SOLD AT $530 AND ONE FOR $2,000.



HAMPSHIRE DOWN RAMS, 3 MONTHS OLD. SOLD FOR $150 EACH.

gives the reasons that have changed his opinions. The following is a translation of the article in its entirety:

> The notable presence of the Down type in the recent exposition of the Rural Society shows a significant fact. The sheep industry of this country is about to enter upon a new evolution. The supremacy of the Lincoln race belongs to the history of the past. But it will not resign its empire without preserving the feudal titles which belong to it by right and tradition. Hence it is to be concluded that the Lincoln breeder who writes this, on welcoming his competitors, is not disposed in any way to quit the field.
>
> After sixteen years of continuous demand for wool and carcasses of the Lincoln cross—every time less cross and more Lincoln—we find ourselves to-day with the British ports closed,[a] the coarse wool despised, and our market limited to the demand—not very encouraging—of three freezing establishments. The time has therefore arrived to balance accounts with the sheep industry, and I now make some observations which this state of things will have suggested, without doubt, to more than one breeder.
>
> First. The production of crossed wool, fine and middling, diminishes in my flocks. Every time there is more coarse wool. The more I try to mark my flock with the seal of the Lincoln the greater is the amount of wool "de padres" that my consignee rejects. What I mean is that the producer and consumer are going in opposite directions. When I think that my labor will be rewarded and exhibit a Lincoln flock typical and uniform, my consignee rewards me by sending my wool to make carpets in North America.
>
> Second. It seems that it is not enough that my wool is valued in an order inverse to the refinement of my flock. The meat market acknowledges still less the merit of so many sacrifices. Even before the closing of the British ports the exporter talked to me about the mutton of the Lincoln type as being too pronounced, too large, too heavy. As soon as the demand was limited only to the market of the freezing establishments the diminution of value of the Lincoln mutton was more accentuated than ever. After twenty years of laborious progress I have seemingly achieved the result of producing a mutton whose only destiny is the grease tank.
>
> Third. To these tribulations there is another to be added—that of the worm. It is noticeable that when you have succeeded in establishing a remarkable Lincoln type in the flock, that is the time this worm causes the greatest damage. There is a predisposition on the part of the yearling lambs to fall victims to *Ovine pasteurolosis* and to succumb to its effects. The spring brood experiences more and more every year a notable decrease during the dry and hot months of the following fall. Our afflicted shepherd will surely not find a ready and easy solution of the problem which confronts him; and if some of the causes that have contributed to this painful situation are marked out, it depends on the ability of each individual to apply them to his own case and to determine which modifications ought to be introduced.
>
> The good prices obtained during the last decade for the wool and mutton of Lincoln cross have induced us to overstock our ranges with sheep. This was a great mistake. It is not enough that during certain periods of the year sheep are fat if at other times they are insufficiently fed. This overstocking has brought what the English call "dirty pasture," and consequently the scale of mortality increases.
>
> The true Lincoln type has experienced a modification in this country, owing to the demand for size. Its fleece has lost the uniformity which characterized it twenty years ago. Its form has been exaggerated. The purity of the type has been somewhat sacrificed in order to obtain a large quantity of meat and volume of wool.

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[a] November, 1902.

Vigor and vitality—qualities necessary to transmit in their purity to the breed—have been sacrificed in this way.

A ram born and bred in the stable, artificially fed from its birth and forced to a precocious development, can not transmit to its descendants the qualities of robustness necessary to our system of sheep breeding. The English breeds do not owe their good reputation to measures taken against nature, nor have their typical qualities been produced in this way, and the practice in our breeding establishments, whose only object is a great development, is too artificial. It is true we ought not to neglect the breeding animals destined for the exposition, and we ought to feed them with the best fodder, keep their fleece in the best condition, and put into practice every legitimate art to present them in the most perfect way before the public. But it seems only reasonable, nevertheless, to allow them at least to breathe the pure air of the field and not the heavy atmosphere of a half-closed and half-dark stable, to oblige them to walk and to graze, and lastly to always keep in mind in preparing them that the breeder produces wool and meat in God's pastures and not in a factory lighted with electric light.

Passing over the causes why the Lincoln breed has not given all the results desired by its advocates, we come to another condition of our national flocks, to wit, their tendency toward unification. No one will deny the beneficial results of crossing the half-breed weak Merino with the robust Lincoln, to whose blood we are indebted for the improvement of form, the firm and healthy basis, and the rugged constitution which contribute to strengthen our sheep in the struggle against the open-air life and the climatic, topographic, and economical conditions of our system of sheep breeding. But the law of compensation is applied to stock breeding as well as to other industries. We ought not to seek either the one or the other extreme, but a medium. The demand of the market does not justify the production of an exaggerated specialty, because in order to obtain this specialty it is necessary to sacrifice certain qualities for the benefit of others, and sooner or later defects appear. In this respect the Lincoln breed has, or, to speak more correctly, had grown too popular.

The stock-breeding economy, as well as all others, is an unending history of ingrafting. The law of nature marks the step, always modifying, always molding, always surprising us with her evolutions, always reminding us while we painfully advance through the way of progress that man lives by the sweat of his brow and putting in our way obstacles which subdue our pride at the very moment when we thought we had reached the summit of our ideal. But, as she is also a good mother, she relieves our affliction by showing another way, until then unknown to us, by which she allows us to progress again, to advance, and to hope.

To ingraft, or, using breeding terms, to cross the typical features of the breeds that are crossed is a prime consideration. It is well known that consanguinity marks its procreation with all the characteristic conditions of the progenitors, be they good or bad, and that consanguinity has been the means employed by the breeder to reproduce the type he wished to perpetuate. In the crossing of the breeds, the greater the typical purity of the progenitor the greater is the perfection reached in the offspring. We start, then, if we intend to cross again, from a basis surer than the one of twenty years ago. The coarsenesss of the mixed Lincoln flocks of the country shows a condition more rational, more typical than the mixed Merino flocks showed then. We rely on the existence of a stock of rams of the Rambouillet, Lincoln, and Down breeds that will supply the demand for sires of excellent pedigrees. The national sheepfold is well equipped. There are elements to modify, in a satisfactory way, the existing sheep.

But outside the modest ability of the breeder who writes these lines, it surpasses the limits of an article to explain in detail the process through which our national flocks will approach more nearly to a profitable medium and to the balance of production, which is so evidently lacking. In the first place, we ought to realize better the limitations to which we are subjected by the climatic and topographic conditions of the regions in which we raise our sheep. It is probable that the sheep breeder situated among the tender natural pastures of the South, in the climate of frequent and copious rains and damp atmosphere, whose flock of accentuated Lincoln type does not increase in the value of wool and meat, would find it advantageous to do what in New Zealand has given such satisfactory results, viz, to cross his Lincoln with Romney Marsh. The Kentish sheep contributes to impart smoothness, thickness, and to a certain extent fineness to the fleece of coarse Lincoln, while the meat of this crossing is in good demand, and a greater constitutional robustness is noticeable in the offspring.

The breeder with alfalfa pastures will never be a great sheep breeder. His rôle is in the cattle business. The development of the sheep industry on the alfalfa stock farms is incompatible with the production of fine wool, of whatever breed, either Merino, or Lincoln, or any other. The problem for the man with alfalfa has but a single economic side—to produce the best and greatest quantity of meat and to find out the type which will best answer this question only.

While the freezing establishments and the exporters of live sheep do not reward quality, paying for an animal of the Down cross a price greater than that paid for an animal of Lincoln cross, it is to be expected that the breeder will always prefer the animal of greater weight. But there are reasons for thinking that this will not always be so and that the Down breeds, crossed on the flocks of Lincoln origin, are destined to modify the general type of the flocks in the alfalfa regions.

In the outlying ranges of the Southwest—the zone of scanty rain and dry atmosphere, separated by long distances and expensive freights from the meat markets—the production of fine wool approximating to the Merino should be the first purpose of the breeder. The long wool of the English white-faces does not prosper there. The conditions of the climate favor the Merino breed. With the opening of a nearer meat market, with the improvement of the virgin range, and the planting of artificial pastures the meat production of that zone might become a more important factor than it is to-day. In this case the breeder will experience another process of evolution, seeking from among the meat breeds whose fleece is the most like the Merino—perhaps the Shropshire—a new cross which will make his flock a source of greater profit in the production of mixed products.

The Argentine breeder needs an increasing number of establishments in which the typical breeds of his specialty are produced. The pure, crossed, or mixed sire will disappear in time, to be replaced by the genuinely, genealogically, typically pure sire. The sheep breeder is called upon to produce, at a moderate price, for the wholesale sheep raiser a flock ram for the general flock, of a type and condition distinctly generic, who will not only give sons, but sons like himself. This will promote the union of the national flock, whose production will improve the more it approaches the medium of the distinctive qualities of each breed. But no breed, no crossing, will permanently contribute to the improvement of the flock if the breeder is not first imbued with the principles of economy. Before finding fault with the Rambouillet, or the Lincoln, or the Down, it will be well to think about the economic system of the farm. In our eagerness to produce much, and of the best, we have exacted more from the soil than the soil could give. The pastures have been overcharged with sheep; the richness of the soil has been exhausted, and the epidemics of worms and other like tribulations that persecute us are but the silent protest of nature, whose fertility has been prostituted.

A good friend of the Argentine Republic, the late John Nash, of good memory, importer of purebred animals, and one of the pioneer stockmen in the alfalfa region of the province of Santa Fé, used to say that half of the crossing of breeds in stock enters through the mouth. We are not yet ready to dispense with these rustic aphorisms of the old world. If we want to obtain better incomes, better fleeces, better carcasses, we must not forget that the most classic ram in existence was not a beauty of Divine origin, but that he had once, in a period more or less remote, ancestors as vulgar, as inferior, as common as a bull of the wild herds from the Falkland Islands. There is no royal road to the perfection of cattle or sheep. We follow a path obstructed at every step by disappointments and unexpected obstacles. The improvement of the domestic breeds is a slow process which never reaches completion. We need not only intelligence and theory, but a continuous, indefatigable method adapted to the country—throwing now and then a glance toward the past—if we want to be able to say we progress.

ARGENTINE RESOURCES SHOWN BY EXPORTS.

The importance of Argentina as a food producer for other parts of the world across the sea is yearly coming to be better understood, as she sends more wheat, more corn, more beef, more mutton, and more butter nearly every year than the one before. And the Argentines and those from other lands who have been attracted to Argentina by the richness of the country and its boundless possibilities are getting a better understanding of their opportunities and how to make the best use of them. For the most part, however, the native Argentine, the descendant of the older families, prefers to confine his efforts to stock raising, agriculture, and politics, leaving the development of trade, of industries, and most commercial pursuits to foreigners. Naturally, the foreigners' profits in developing Argentine resources have been large. The freezing companies that send frozen beef and mutton to England, South Africa, and other markets have been earning 40 per cent dividends. There is a large margin in the butter business. Fortunes have been made in grain. But these conditions are not always to prevail, and, indeed, are changing already. There is a new generation in which there is much new blood, and these young men are ambitious to do more than raise stock and get into the provincial or national legislative bodies or hold some other official post.

Last year the Argentine energy in hunting markets was shown by the manner in which they went after the South African market. The Argentine department of agriculture rented a big transport from the navy department and sent several experimental cargoes to South Africa. They took mules, steers, horses, butter, alfalfa, wheat, oats, sheep, and many other things in small parcels on the owners' private account. It was all sold to good advantage, and convinced both shipowners and producers that the market was worth working for. Now there are three regular shipping lines, with frequent sailings, and a good trade has sprung up. Some of the trade has not turned out so well as was hoped, but the experimental cargoes, sent at the lowest possible cost to shippers, have built up a trade that would not have been developed otherwise, and which is worth many thousands of dollars every month to the Argentine producers of food products, alfalfa, etc.

The British ports were closed to Argentine live stock during all the year 1902, and also in 1901, owing to the foot-and-mouth disease which was so severe in the year 1900. This had been the chief market for Argentine steers, wethers, and lambs. Notwithstanding this, the exports of live animals during 1902 amounted to $5,617,696 gold, an increase of $2,532,941 over 1901. Of this increase, $1,033,800 was for mules, most of which went to South Africa. That was only a temporary business, for the trade is now back to its normal condition. In 1899 Argentina exported 312,150 steers, nearly all to England. Last year she sent 118,303 to various places, and this was nearly all new business, worked up in the last two years. It was 886 fewer than were exported in 1901, but the prices realized amounted to $868,073 more in 1902. These cattle went to Spain, Portugal, South Africa, and Brazil. They were not equal to the best type of export steer that Argentina sent to England this year, but the business made better prices for a fair type of steer.

With the British ports open to the steers and sheep of Argentina, it is the ambition of every producer of steers and mutton sheep to raise animals that are fit to meet the demands of the export market. If he has rather bad luck at first in trying to compete with the United States, it only drives him to the improvement of his product to meet the conditions of the market in which the best prices prevail. That he will do this there is not the least doubt, for he has all the facilities for doing it. With cheap land, cheap labor, and a climate so favorable for the production of corn and other feed, and so kind to stock that they need no shelter the year around and are almost sure of abundant green feed during every month in the year, it will probably not be long before as good steers will be produced there as can be produced anywhere.

Gains are shown in the exports in nearly all important lines except wheat, flour, and wool. This year the corn crop will be almost double that of last year, and all the estimates of exports double the amount of last year, or nearly so. The wheat crop also will be very much heavier, probably double, as the crop of 1902 was far below the average. Wool exports this year are, up to the 1st of May, less than the same period last year, but the prices are much better. The year, in short, is a most prosperous one for the Republic. Crops generally have been good and prices are satisfactory. So are the prices for cattle and sheep, and the demand is putting the prices up a little more every week for good fat wethers, till now they are worth $12 paper for the best.

The Argentine Government collected $3,210,307 gold in export dues in 1902, of which all but $29,850 was on animal products. The following export products are taxed 4 per cent on their gold valuation as fixed by the current market prices: Wool, all kinds of hides and skins, horns, horsehair, tallow, animal and fish oil, bone ash, hide clippings, bones, hoofs, ostrich plumes. Old iron pays 5 per cent, and all other products are free.

PRINCIPAL EXPORTS FOR FIVE YEARS.

The following table shows the principal exports of animals and animal products from Argentina for the past five years. (Where tons are given metric tons of 2,204 pounds are understood.)

Exportation of principal products during the last five years.

Animals and animal products.	1898.	1899.	1900.	1901.	1902.
Steers .... number..	359,296	312,150	150,150	119,189	118,303
Wethers .... do....	577,813	543,458	198,102	25,746	122,501
Horses .... do....	14,360	7,259	32,969	9,761	16,008
Mules .... do....	10,205	7,740	13,179	20,468	54,928
Frozen beef .... tons..	5,867	9,079	24,590	44,904	70,018
Frozen mutton .... do....	59,834	56,627	56,472	63,013	80,673
Unwashed sheepskins .... do....	42,245	41,697	37,593	41,120	41,405
Salted cowhides .... do....	29,370	28,528	26,423	28,158	35,343
Dry cowhides .... do....	23,174	23,956	24,866	26,647	26,558
Salted horsehides .... do....	160,[illegible]39	134,774	121,285	136,901	135,685
Dry horsehides .... do....	180,827	130,057	190,241	181,027	282,138
Wool .... do....	221,280	237,111	101,113	228,358	197,906
Jerked beef (tasajo) .... do....	22,242	19,164	16,449	24,296	22,304
Various frozen meats .... do....	971	922	1,089	1,410	2,520
Canned beef .... do....	1,023	1,816	1,405	947	1,644
Tallow .... do....	29,341	24,150	24,837	33,368	49,095
Butter .... pounds..	2,042,562	2,600,317	2,327,506	3,329,338	9,093,975

EXPORTS IN DETAIL.

The animal exports of the Argentine Republic for the calendar year 1902, in quantity and value, compared with the previous year, ended December 31, 1901, are given herewith. All measurements have been reduced to those of the United States except tons, where the metric measurement has been left unchanged. The valuations are in Argentine gold, the dollar of which is worth 96.5 cents United States money.

Exports of animals and animal products during calendar year 1902 compared with 1901.

Animals and animal products.	Quantities.		Values.	
	Number or quantity in 1902.	More (+) or less (−) than in 1901.	Value in 1902.	More (+) or less (−) than in 1901.
Asses .... number..	14,223	+ 5,430	$284,460	+ $108,600
Cattle .... do....	118,303	− 886	2,848,445	+ 868,073
Goats .... do....	2	− 1	10	....
Horses .... do....	16,008	+ 6,247	460,035	+ 227,560
Mules .... do....	54,928	+ 34,460	1,647,840	+1,033,800
Sheep .... do....	122,501	+ 96,755	368,656	+ 290,408
Hogs .... do....	532	+ 282	8,250	+ 4,500

Exports of animals and animal products during calendar year 1902 compared with 1901—Continued.

Animals and animal products.	Quantities.		Values.	
	Number or quantity in 1902.	More (+) or less (−) than in 1901.	Value in 1902.	More (+) or less (−) than in 1901.
Horns ....tons..	2,475	+ 671	$197,988	+ $42,660
Frozen beef..do....	70,018	+ 25,114	7,001,833	+2,511,386
Frozen mutton ....do....	80,073	+ 17,060	6,405,804	+1,364,781
Horse hair..do....	2,651	+ 88	1,064,646	+ 59,969
Sheepskins..do....	41,405	+ 285	8,487,078	+1,147,266
Salted cowhides ....do....	35,343	+ 7,185	6,384,955	+1,103,199
Dry cowhides..do....	26,558	− 89	8,822,302	− 26,136
Wool..do....	197,936	− 30,422	45,810,749	+1,144,266
Jerked meat (tasajo) ....do....	22,304	− 1,992	2,647,450	− 232,005
Various frozen meats..........................do....	2,520	+ 1,110	163,820	+ 72,172
Salted horsehides. ....number..	135,685	− 1,216	406,794	+ 15,968
Dry horsehides ....do....	282,138	+101,111	460,906	+ 167,501
Goatskins..........................pounds..	3,025,185	+116,050	823,328	+ 31,583
Kid skins ....do....	1,075,494	− 43,318	292,704	− 11,790
Pickled tongues ....do....	1,221,093	−274,887	166,164	− 37,409
Salted tongues..........................do....	23,289	− 3,600	1,690	− 262
Pressed tallow ....do....	113,903	+101,467	3,617	+ 3,222
Canned beef ....tons..	1,644	+ 697	164,404	+ 69,687
Butter ....do....	4,125	+ 2,615	1,277,969	+1,100,424
Rendered fat and tallow ....do....	49,095	+ 15,727	6,209,038	+2,306,323
Sole leather..........................number..	16,633	+ 14,662	83,165	+ 73,215
Tanned cowhides..........................do....	134	− 286	268	− 572
Tanned sheepskins..........................dozen..	140,914	+140,914	563,656	+ 563,656
Other tanned skins..........................	....	....	417	− 205,221
Extract of beef ....pounds..	653,329	+175,382	592,696	+ 159,106
Cheese ....do....	14,374	+ 11,400	1,304	+ 1,034
Casein ....do....	207,395	+207,395	21,839	+ 21,839
Animal oil..........................do....	381,859	+ 54,436	20,412	+ 5,182
Concentrated soup..........................do....	86,480	− 32,692	11,769	− 2,448
Bone ash..........................tons..	13,769	+ 9,332	94,865	+ 69,226
Clippings of hides..........................do....	1,803	+ 430	41,637	+ 2,167
Guano ....do....	1,455	+ 639	36,385	+ 14,374
Bones..........................do....	35,059	+ 7,557	341,732	+ 24,019
Hoofs ....do....	1,093	+ 344	13,660	+ 4,303
Dried blood..........................do....	925	− 77	46,271	− 3,849
Salted tripe, sausage casings, etc..............do....	2,189	+ 282	109,457	+ 14,101
Dried tripe, sausage casings, etc............pounds..	286,353	+106,751	5,196	+ 1,937
Burned bones..........................do....	....	− 50,000	....	− 5,000
Grease scraps ....do....	2,388,356	−127,082	54,166	− 2,883
Ostrich feathers ....do....	103,804	− 28,792	86,122	− 35,000
Eggs..........................dozens..	4,798	+ 4,798	480	+ 480
Bristles ....pounds..	23,713	+ 23,713	430	+ 430
Chicken feathers..........................do....	29,112	+ 6,845	660	− 140

DISTRIBUTION OF EXPORTS.

The following table shows the distribution of the principal Argentine exports in 1902, as reported by the national statistical bureau. Giving only certain countries, the destination of a large part of certain articles is lost sight of. This is noticeable in the shipments of horses, cattle, and sheep, most of which went to South Africa. Many ships sail from Argentine ports bound for St. Vincent "for orders," and they do not know until they reach that port where they will be ordered to take their cargo. The shipper has the two or three weeks that the ship requires to make the voyage to this point to determine where he will sell the cargo. Hence the Argentine port records never show where these cargoes were sold, but they are all for European or English ports.

Exports of animals and animal products, 1902, and their destination.

Country of import.	Cattle.	Horses.	Sheep.	Horse-hides.	Frozen beef.	Frozen mutton.	Jerked beef (tasajo).	Wool.
	Number.	*Number.*	*Number.*	*Number.*	*Metric tons.*	*Metric tons.*	*Metric tons.*	*Metric tons.*
Belgium	....	44	....	700	....	....	239	22,342
Brazil	28,923	1,205	3,550	100	....	3	13,841	5
France	103	191	500	1,000	....	....	191	86,007
Germany	....	59	....	313,707	....	....	12	49,750
Italy	....	4	....	19	....	....	3	1,905
Spain	1,124	141	1,452	849	....	....	68	....
United Kingdom	....	383	....	100	54,402	70,371	451	11,216
United States	....	....	....	47,915	....	....	366	12,420
Uruguay	47,884	1,625	335	5,601	....	....	2,355	151
Other destinations	39,328	12,352	116,480	47,832	15,616	9,699	4,778	13,687
For orders	941	4	184	....	....	....	....	453
Total	118,303	16,008	122,501	417,823	70,018	80,073	22,304	197,936

Country of import.	Bones.	Salted cow-hides.	Dry cow-hides.	Sheep-skins.	Kid and goat skins.	Ostrich feathers.	Horse-hair.	Tallow.
	Metric tons.	*Metric tons.*	*Metric tons.*	*Metric tons.*	*Pounds.*	*Pounds.*	*Metric tons.*	*Metric tons.*
Belgium	1,474	5,249	697	1,003	40,683	18,743	643	1,285
Brazil	....	....	4	54	....	441	....	2,067
France	956	2,127	450	23,829	1,426,050	33,766	51	3,709
Germany	3,388	13,308	1,021	2,299	....	1,429	167	1,828
Italy	1,426	167	2,523	2,693	3,527	908	429	6,024
Spain	121	316	2,915	16	20,192	8,331	....	4,961
United Kingdom	3,304	2,850	227	3,962	1,043	....	88	26,140
United States	14,009	4,086	11,990	20	1,374,436	24,339	424	254
Uruguay	983	1,725	2,945	519	3,005	2,498	397	189
Other destinations	5,305	4,552	3,786	7,010	1,231,743	13,349	452	2,638
For orders	4,093	963	....	....	....	....	....	....
Total	35,059	35,343	26,558	41,405	4,100,679	103,804	2,651	49,096

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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY—Bulletin No. 49.

D. E SALMON, D. V. M., Chief of Bureau.

THE COLD CURING OF CHEESE.

Report upon Experiments Conducted Under the Auspices of the U. S. Department of Agriculture, Bureau of Animal Industry, Dairy Division, in Cooperation with the Wisconsin Agricultural Experiment Station and the New York Agricultural Experiment Station.

BY

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AND

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., August 1, 1903.

SIR: I have the honor to transmit herewith a manuscript on the cold-curing of cheese, being a report of a cooperative experiment of the Dairy Division and the experiment stations of Wisconsin and New York. The work has been very complete and the results satisfactory in a high degree, and I therefore recommend that this manuscript be published as a bulletin of this Bureau.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., June, 1903.

SIR: I have the honor to submit herewith, in manuscript, reports made by officers of the agricultural experiment stations of Wisconsin and New York upon experiments in the cold-curing of cheese recently conducted in cooperation with the Department of Agriculture, and recommend publication of the same as a bulletin of this Bureau.

The work has been under the general supervision of the Dairy Division, and I desire to acknowledge the cordial cooperation of the two experiment stations named and their respective representatives, the material assistance of the cold-storage companies at Waterloo, Wis., and New York City, and the important and efficient services of the cheese experts who acted as scorers or judges, as described in the reports.

Very respectfully, yours,

HENRY E. ALVORD,
Chief of Dairy Division.

Dr. D. E. SALMON,
Chief of Bureau of Animal Industry.

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THE COLD CURING OF CHEESE.

INTRODUCTION.

By Henry E. Alvord, C. E.,
Chief of Dairy Division, Bureau of Animal Industry.

The prevalent opinion among cheese dealers has always been that low temperatures, varying from 35° or 40° to 50° F., or thereabouts, resulted in the production of an inferior quality of cheese, in comparison with that from 60° to 70° F. No carefully controlled experiments bearing on this problem have been recorded earlier than those undertaken by Babcock and Russell at the Wisconsin Agricultural Experiment Station, and described in the Fourteenth (1897) Annual Report of that station. The results of those tests showed that cheese placed at refrigerator temperatures (45° to 50° F.),[a] directly from the press, was of superior quality as to flavor and also as to texture, and that such cheese was wholly free from any bitter or other undesirable taints.

In connection with their studies on the influence which galactase and rennet extract exert on the progress of cheese ripening, the same investigators later employed still lower temperatures (25° to 30° F.). Cheeses were kept at these excessively low curing temperatures for a period of eighteen months. The quality of these cheeses, cured as they were below the freezing point throughout their whole history, was exceptionally fine, and emphasized still more than the previous experiments did the fact that the ripening of cheese can go on at much lower temperatures than has heretofore been considered possible.

These results led to an extended series of experiments, in which cheese made on a commercial scale was cured at a range of temperature from below freezing (15° F.) to 60°—a point which common practice has now accepted as the best obtainable temperature that can be secured without the use of artificial refrigeration.

In these experiments (consisting of five series made at intervals throughout a period of two years) 138 cheeses were used, for which 30,000 pounds of milk were required. These experiments were upon a scale which represented commercial conditions, and therefore obviated the objection which is often urged in commercial practice against the application of results derived simply from laboratory experiments.

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[a] The first public presentation of these experiments was made at the meeting of the Wisconsin Cheesemakers' Association, in February, 1901.

The results of these tests may be found detailed in Bulletin No. 94, and the Eighteenth (1901) and the Nineteenth (1902) Annual Reports of the Wisconsin Agricultural Experiment Station.

The Ontario Agricultural College began experiments on the cold curing of cheese in April, 1901. As a result of these tests, the conclusion was drawn that the cheese cured at low temperatures (37.8° F.) was much superior to that cured in ordinary curing rooms (average temperature during season 63.8° F.). Mr. R. M. Ballantyne, a prominent cheese expert, said of this cheese that "they [the merchants] universally expressed surprise at the condition of the cheese that was put into cold storage at the earliest period (that is, directly from the press), as they expected to find the cheese still curdy and probably with a bitter flavor." If this experiment is borne out by other experts, it would appear as if the best way to handle hot-weather cheese would be to ship it to the cold storage directly after making, and this would certainly mean a great revolution to the trade.[a]

More extensive experiments are in progress in Canada, but the results have not yet been published, although general statements have been made confirming previous conclusions.

A considerable number of experiments have also been made at other stations (Dominion government tests and New York State and Iowa experiment stations), where somewhat lower temperatures were used than those which are normally employed for ripening. The results obtained all show an improvement in quality that becomes more marked as the temperature is reduced.

In order that a much larger experiment might be instituted, covering the different types of cheese as represented by Eastern as well as Western manufacture, Drs. Babcock and Russell, of the Wisconsin Station, presented this matter for consideration to the Dairy Division of the Bureau of Animal Industry. As a result of this proposal the officers of the New York Agricultural Experiment Station were also consulted and plans perfected for the cooperative experiments conducted simultaneously in Wisconsin and New York, which are described in full in this bulletin. It should be noted that it was so late in the season of 1902 when the arrangements for this work were completed that it was impossible to obtain favorable conditions in all respects.

It was deemed desirable that the cheese to be tested should represent the product of as wide a range of territory as possible, and therefore it was decided to establish two curing stations—one in the East and the other in the West. Drs. S. M. Babcock and H. L. Russell were put in charge of the Western experiments and Dr. L. L. Van Slyke and Mr. G. A. Smith of those in the East.

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[a] Bulletin No. 121, Ontario Agricultural College, June, 1902.

OBJECTS OF THE EXPERIMENTS.

In addition to the influence which a range in temperature exerts on the quality of cheese, as determined by flavor and texture scores, instructions were also issued to secure data regarding the loss in weight which the different lots of cheese suffered at the different temperatures. The commercial quality of the product was to be determined by a jury of experts who were thoroughly in touch with the demands of the market. Although the effect of coating cheese with paraffin soon after being taken from the hoop was not at first proposed as a part of this work, it was finally included, both East and West.

The reasons for selecting 40°, 50°, and 60° F. as the temperatures to be used in these experiments are fully given on a later page. It may be assumed that the advantages of a cool and even temperature in curing Cheddar cheese have been already established in preference to a warm temperature or to very variable conditions which frequently include periods above 70° and sometimes much higher. As already stated, 60° or thereabouts is regarded as the lowest temperature practicable without artificial refrigeration; this may therefore be taken as fairly representative of what may be called a "cool" temperature for curing cheese. And rooms held at 40° and 50° were selected as representative of a "cold" temperature for curing, or comparatively so. It is thus hoped to emphasize by these experiments the distinction between cool curing and cold curing.

The cheese for these experiments was purchased by the United States Department of Agriculture, which also paid all expenses of transportation and storage and for the experts who made the periodical examinations. The two experiment stations selected the cheese, arranged all details of storage and examination, supervised the work throughout, performed the chemical and other incidental scientific work, kept the records, and reported results.

In order that a uniform system of scoring might be followed in the experiments, the appended score card was used for both:

EXPERIMENTS IN CURING CHEESE AT LOW TEMPERATURES, UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY, DAIRY DIVISION.

Cheese judging—Numerical and descriptive score card.

Score for cheese (or sample) marked……………………………………………………

NUMERICAL SCORE.

PERFECTION:	Flavor 45 points.	Texture 30 points.	Color 15 points.
SCORE:	do. ………	do. …………	do. ………

Date: ……………………………, 190 . Initials of the judge: ………………………………

DESCRIPTIVE SCORE. (Check the faults below.)

Flavor.		Texture and body.		Color.	
Perfect	Clean	Perfect	Silky	Perfect	
High	Flat or low	Smooth	Waxy	Straight	
Too high acid		Pasty	Salvy	Translucent	
Needs more acid		Stiff	Weak	White specks	
Sour	Sweet	Curdy	Mealy	Streaked	Wavy
Tainted	Weedy	Tallowy	Gritty	Mottled	Acid cut
Barny	Cowy	Close	Loose	Too high	Too light
Old milk		Holes, mechanical		Uncolored	
Poor sewerage, dirty cans		Holes, gas	Holes, Swiss		
		Watery	Too dry		

Each of the following reports, prepared by the two experiment stations participating in this work, treats the same general subject and similar lines of experiment and observation from its own point of view. The reports therefore differ in many respects, and yet they may be easily compared upon all essential points. Both support the following general conclusions:

ADVANTAGES OF CURING CHEESE AT LOW TEMPERATURES BRIEFLY SUMMARIZED.

(1) The loss of moisture is less at low temperatures, and therefore there is more cheese to sell.

(2) The commercial quality of cheese cured at low temperatures is better, and this results in giving the cheese a higher market value.

(3) Cheese can be held a long time at low temperatures without impairment of quality.

(4) By utilizing the combination of paraffining cheese and curing it at low temperatures the greatest economy can be effected.

THE WESTERN EXPERIMENTS, 1902-03.

Conducted by S. M. Babcock and H. L. Russell, assisted by U. S. Baer,
Of the Wisconsin Agricultural Experiment Station.

For the purposes of this experiment Chicago would naturally have been chosen as a curing station, but it was found difficult to make arrangements for the range of temperature desired. Suitable arrangements, however, were made at the cold-storage warehouse of the Roach & Seber Co., Waterloo, Wis., where rooms were fitted up and the desired temperatures secured.

SELECTION OF THE CHEESE.

As Wisconsin is the leading cheese-producing State of the West, the bulk of the product selected for experiment was of the type of cheese manufactured in this State. In order, however, to cover more thoroughly the cheese-producing territory of the West, samples were also secured from a number of the neighboring States. In this way all types of American cheese were obtained, ranging from the firm, typical Cheddar cheese, suitable for export, to the soft, open-bodied, moist cheese, intended for early consumption. For convenience we may group these various lots of cheese under three different types, as follows:

I. Close-bodied, firm, long-keeping type, suitable for export trade (typical Cheddar).

II. Sweet-curd type.

III. Soft, open-bodied, quick-curing type, suitable for early consumption.

Type I represents the class of cheese that is especially manufactured in Wisconsin, while, as a rule, type III represents the kind of cheese that is chiefly made in Michigan. The representatives of the sweet-curd type were taken from Iowa and Illinois, although this class is made to some extent in all sections.

The table herewith gives the location of the factories from which the different lots were secured, also the size and amount of cheese so purchased.

Origin of cheese and quantities used in experiments.

Origin and type.	Style.	Number.	Weight.
I.—*Export type.*			
Wisconsin:			*Pounds.*
Thos. Johnston, Boaz, Richland County	Flats	20	662
H. J. Noyes, Muscoda, Grant County	do	18	571
P. H. Kasper, Nicholson, Waupaca County	do	18	588
La Crosse Cheese and Butter Co., Alma, Buffalo County	Daisies	60	1,151
Do	Prints	40	400
II.—*Sweet-curd type.*			
Iowa:			
E. G. Hodges, Union, Hardin County	Flats	20	607
Illinois:			
J. B. Gilbert & Co., Sterling, Whiteside County	do	20	583
III.—*Soft, home-trade type.*			
Michigan:			
A. H. Barber & Co., Merrill, Saginaw County:			
I	Flats	9	287
II	do	9	287
III	do	29	924
IV	do	13	415

In having the cheese made at these various factories directions were given for the use of a uniform amount of rennet and salt. Color was left optional for each maker to follow his customary practice. The use of 3½ ounces of Hansen's rennet extract and 2½ pounds of salt per 1,000 pounds of milk was recommended in each case with the exception of the smaller cheeses (daisies and 10-pound prints), which were salted at the rate of 2¾ pounds per 1,000 pounds of milk. The cheese was made from September 26 to October 4. The condition of the milk was influenced in several instances by the fact that severe frosts had occurred in some sections, which injured the quality of the product. This was particularly true in the case of the Alma cheese, which was in consequence somewhat tainted. The milk from which the Iowa cheese was made was also reported as of inferior quality. The Michigan goods were too high in acid, and were cooked low, making a soft cheese, which was quick-curing and which kept poorly.

Where it was necessary to secure cheese from such a wide range of territory it was manifestly impossible to expect that the curing could be carried out as satisfactorily as if it had been done at or near the factories. The varying period of transit to which the cheese was subjected, with no especial temperature control, affected, of course, the initial stages of curing, but the conditions of the experiment prevented the carrying out of immediate installation of the cheese in the cold curing rooms, especially in the case of those made outside of Wisconsin, although the shipments were made in October, when the temperature range was moderate.

TEMPERATURES AT WHICH THE CHEESE WAS CURED.

The cheese was weighed and put in the respective rooms as soon as received at Waterloo. It was stored in boxes during the curing, as is the custom in the handling of cold-storage goods. The temperatures at which it was desired to hold the cheese for curing were 40°, 50°, and 60° F. These points were selected for the following reasons: In our previous experiments we had found that the character of the cheese cured at the lower temperatures (40° and 50°) was much better than that produced at 60°. Perhaps it would have been better for the purpose of the experiment if the cold-cured cheese could have been compared with the same make of cheese cured under the widely variable conditions which prevail in most factories, where often the maximum temperature is in the neighborhood of 80° F. and the fluctuation is 20° or more; but we have made this comparison with the very best conditions that obtain in factories provided with subearth ducts and other means of temperature control. In such cases a temperature of 60° can be maintained with a fair degree of constancy. The experiments, therefore, compare the cold-curing process with that of the best prevailing conditions.

The temperatures actually maintained varied only slightly from the chosen points, and in the two colder rooms were remarkably uniform. The 60° room was subject to somewhat wider fluctuations, but was much more uniform than is obtained in summer where no artificial refrigeration is practiced. The following table gives the average of all the observations made at regular intervals and the maximum and minimum observed throughout:

Temperature records.

	Cold rooms.		Normal temperature.
	Low.	Medium.	
	° F.	° F.	° F.
Average	36.8	46.9	58.5
Maximum	37.0	47.5	61.0
Minimum	35.0	45.0	57.0

The daily fluctuations were inconsequential, as can be seen by a series of graphs taken from the registering instrument.

DETAILS OF SCORING THE CHEESE.

It would have been advisable to have the cheese examined a considerable number of times by the commercial judges, but it was impossible to carry out this test so frequently. The tests were therefore arranged to come at those periods which would give the judges the most accurate idea of the character of the cheese held at the different temperatures.

As a jury of commercial experts, representing the different markets, the following gentlemen were selected: C. A. White, of Fond du Lac, resident representative in Wisconsin of a leading dairy produce house of New York; T. B. Millar, of London, Ontario, a cheese expert and large buyer for the export trade, and John Kirkpatrick, a member of a leading produce firm of Chicago.

For the jury trials representative cheeses were taken from storage and shipped by refrigerator service to Chicago, where they were submitted to a thorough examination by the commercial judges. The first of these commercial scorings was made when it was found that the 60° product was ready for market. This test was made on January 6, 1903. Another test was made on March 23, when the cheese was about 7 months old.

It might at first thought seem preferable to have had the cheese sold in the open market and thus secured a strict commercial valuation on the product, but, as everyone knows, a considerable variation in quality may exist without an appreciable difference being made in the market price. Then, too, the inevitable fluctuations in the market price would render comparisons at different periods untrustworthy. To obviate these difficulties the cheese was scored on the basis of a standard price (13 cents). The fact that but few of the cheeses reached this standard should not be interpreted as indicating a poorer quality than the average market product, for the cheese was adjudged by the jury to be superior in quality; but the price was in part determined by the market appearance of the goods, which was somewhat inferior because of the fact that they had been box-cured and had received practically no care in curing, as the curing station was located at a distance from Madison.

The scores of the commercial jury were supplemented by a series of scores made by Mr. Baer which covered the entire history of the cheese from the time it was received until its final disposition. In this study it was possible to follow more closely the course of the ripening.

RESULTS OF EXPERIMENTS.

In presenting the data gathered in these experiments we have placed all of the detailed scores made by both the expert judges and Mr. Baer in an appendix. The following text is prepared from a study of these data, but only summaries are given in the text from which the deductions are made.

In outlining these results the data on shrinkage in weight during the experiment will first be given, followed by the serial scores made by Mr. Baer and the jury records obtained at the tests made when the cheese was three and five months old.

PART I.—SHRINKAGE OF CHEESE IN WEIGHT WHEN CURED AT DIFFERENT TEMPERATURES.

The losses in weight which cheese undergoes in the curing process is a matter of such practical importance that it is advisable when possible to accumulate data relating to it. This is all the more important in this connection because no studies have yet been reported on cold-cured cheese, and it was therefore deemed advisable to keep a record of the losses in weight so that the shrinkage at these lower temperatures might be compared with those which normally obtain at the best temperatures now employed. The average shrinkage under existing curing conditions in the majority of factories results in a loss of 5 to 7 per cent for the first thirty days, with a gradually diminishing rate for larger curing periods. This results in a heavy tax to the producer, and any factor which reduces these losses increases thereby the total receipts from the milk produced.

FACTORS INFLUENCING THE RATE OF LOSS.

There are a number of factors which modify the rate at which a cheese loses its water content during the course of ripening. The following factors are known to exert a more or less marked influence, although it is impossible to arrange them in order of their relative importance, as they are always interdependent: (1) Temperature of curing room; (2) relative humidity of air in curing room; (3) size and form of cheese; (4) moisture content of the cheese; (5) protection to external surface of the cheese.

The influence of temperature is closely connected with the relative humidity of the curing room; but, in addition to the effect which the higher temperatures exert on this factor, it should be observed that water evaporates more rapidly at a high than at a low temperature, even though the relative humidity remains the same. The more potent influence of temperature is, however, the effect which varying degrees of heat exert on the relative humidity of the atmosphere. A fall of 20° F. from ordinary air temperatures practically doubles the relative humidity, provided the point of saturation is not passed. As the average relative humidity of the air is generally over 50 per cent, it therefore follows, in cold-curing rooms supplied with outside air, the temperature of which is from 30° to 40° F. higher in summer than the inside temperatures, that the air of these rooms is practically saturated, thus greatly reducing the loss of moisture from the cheese.

So far as the cheese itself is concerned, the moisture of the room may be materially altered by the way in which the cheese is handled during the curing process. If the cheese is shelf-cured, as is the custom in most factories, the surrounding air more nearly approximates the average relative humidity of the entire room than is the case where the goods are box-cured. In the latter case the air is more nearly saturated, as is shown by the greater liability to mold and rind-rot.

This point is well shown in a series of observations on the relative humidity of the air in a box containing a cheese placed directly therein from the press.

To show this the following observations were made: Wet and dry bulb thermometers (Hydrodeik) were placed in a Cheddar box with a 30-pound flat. An opening was made in the top and covered with glass so that observations could be made directly without opening the box. The apparatus was placed for a period in rooms at different temperatures and the observations recorded as follows:

Relative humidity of air surrounding box-cured versus shelf-cured cheese.

	Temperature range.	Relative humidity.	
		Room.	Cheese box.
	° *F.*	*Per cent.*	*Per cent.*
Room I	35–40	85–92	100
Room II	50–55	55–75	94
Room III	60–69	50–70	84–90

A factor which is frequently overlooked is the varying moisture content of the cheese. The more moisture there is left in the cheese the more rapid the evaporation. The varying moisture content of different types of cheese is determined by the temperature at which the curds are cooked, the time of exposure, and the acidity of the curd. A cheese in which the acidity is developed is materially drier than a sweet-curd cheese. Salt also has a tendency to diminish the water content. In the foregoing cases the cause of this diminution in moisture is due to the shrinking of the curd particles under the influence of these factors. An increase in fat lessens the drying of the curd. Much loss of moisture can also be prevented by coating the cheese with paraffin, a practice which is now coming into very general use for the prevention of mold and to lessen shrinkage in weight.

EXPERIMENTS IN SHRINKAGE OF COLD-CURED CHEESE.

In these experiments the first careful weighings were made when the cheese was received at the cold-storage plant in Waterloo. The cheese was shipped from the factories directly after it was removed from the press, but was in every case several days upon the road. In no instance was the interval between making and installing in cold-curing rooms less than five days, and it ranged from this up to seventeen days with one lot from Michigan, which was delayed in transit. During this period, which was in early October, the cheese was subjected to varying conditions of temperature and exposure. In a few cases boxes were broken, and in other instances the cheese was delayed at points of transfer. It was impossible to obviate these difficulties, as the cheese was purchased at distant points in order to secure representation from a wide range of territory and from different types of cheese. This variation in initial drying changed, of course, the rate of loss when cheese was placed in cold-curing rooms, so that this factor must be taken into consideration in studying the data presented below.

The losses reported here cover those only which took place in the cheese after it had reached the cold-curing rooms, but careful records have been kept for the entire curing period; and these data, we believe, are of sufficient importance to warrant full consideration in this connection.

DETAILS OF WEIGHING.

The cheese was all weighed on counter scales, weighing accurately to fractions of an ounce. In order to check the accuracy of the weights, each cheese was weighed separately and the weight recorded; then the whole lot was weighed collectively. As these weights agreed within a few ounces, they show the accuracy of the weighings. For practical purposes it is desirable to know the losses which occur for stated periods. It was, however, impracticable for all of the cheese to be weighed at exactly the same intervals, as it was put in storage at different dates, but it was designed to secure at least three weighings for the first month of storage, two weighings for the second, and at about monthly intervals thereafter. If these data are charted, it is possible to deduce an estimated loss for any stated period, and in doing so we have selected the following intervals as being those concerning which data would be most frequently desired. For this purpose ten, twenty, thirty, sixty, ninety, etc., days have been selected.

CONDITIONS UNDER WHICH THE CHEESE WAS STORED.

In this work the attempt was made to hold the cheese at 40°, 50°, and 60° F. The actual temperatures secured averaged 36.8°, 46.9°, and 58.5° F. The variation in temperature in the two lower rooms was practically negligible, as it was only 2° to 2½°. The temperature of the 60° room oscillated somewhat more (4° F.), but was very much more uniform than ordinary factory curing rooms. (See figs. 1, 2, and 3 for samples of the thermometric record.)

Hygrometric data were not secured during the whole period, as it was at first thought that a saturated atmosphere would prevail where the cheese was box cured, but during the course of the experiments it was noted that the 50° cheese was not molding as much as was that at 40° and 60°. This fact could only be explained by the assumption that a less humid atmosphere was present in the case of the 50° room.

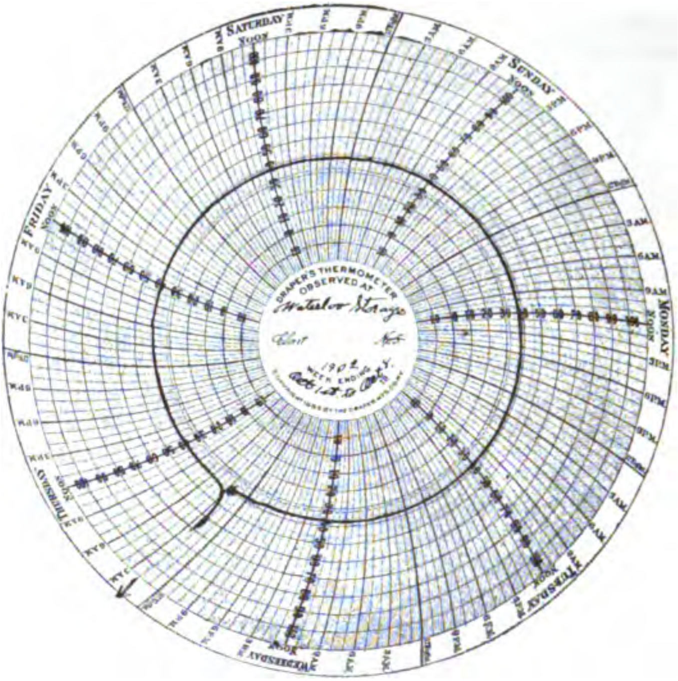

FIG. 1.—Temperature record of 40° curing room.

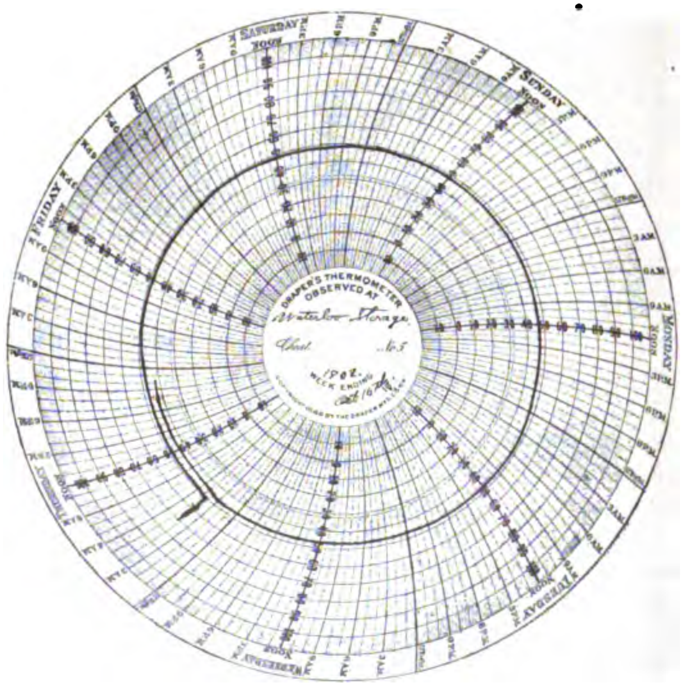

FIG. 2.—Temperature record of 50° curing room.

Observations at the end of the experiment showed a relative humidity in the different curing rooms as follows:

	Temperature.	Relative humidity.
	° *F.*	*Per cent.*
Room I..	37	92
Room II.	48	73
Room III	59	72

It will be observed in the figures later presented that the difference in rate of loss at 50° and 60° was higher toward the end of the experiment than in the earlier stages. This probably means that the relative humidity of room III was diminished at this time, bringing it down from a moister state to approximately the same humidity as the 50° room. If this was so, this would account for the lessened development of mold at 50°, as mold is very sensitive to hygrometric conditions.

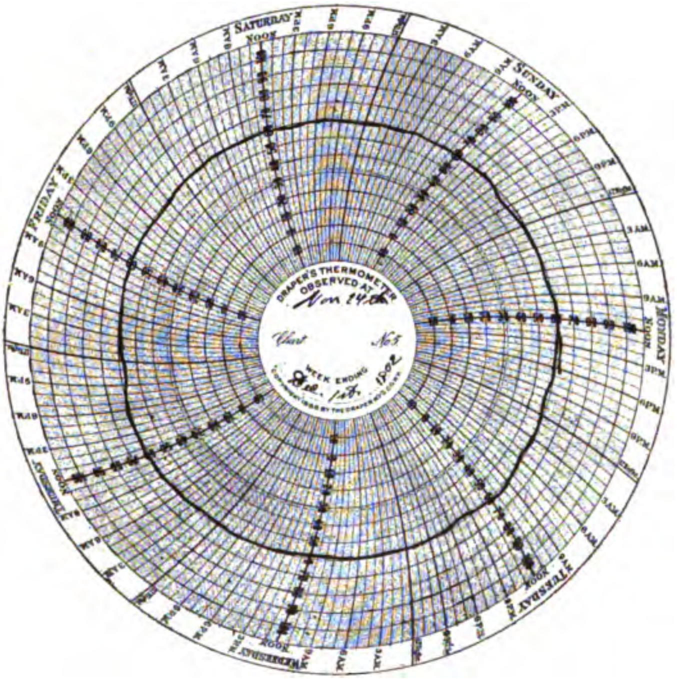

FIG. 3.—Temperature record of 60° curing room.

DISCUSSION OF RESULTS.

As there are several factors which affect the rate of shrinkage which the cheese suffers in curing, it will be desirable to discuss the data collected under several heads. The conditions of the experiment were such as to temperature that an especially favorable opportunity was had for the study of the influence which this factor exerts on the cheese. It is, of course, necessary in a study of this sort to have the cheeses uniform in size. The moisture contents of the cheese can not, of course, be made alike, but in this study the cheeses of the same type have been grouped together -that is, as firm Cheddars suitable for export and softer, moister cheese intended for home trade.

A. INFLUENCE OF TEMPERATURE ON SHRINKAGE.

To study the rate of loss of Cheddar cheese when kept at different temperatures, 129 flats were selected from nine different lots of cheese made by six different makers. These were exposed at three different temperatures, which averaged, respectively, 36.8°, 46.9°, and 58.5° F. In each of the tables herewith is given the number of cheeses which were subjected to stated weighings. It will be observed that much more data were collected on the lower temperatures than on the 60° lot. This was regarded necessary, as up to this time we have no published data on cheese cured at so low a temperature. The following tables give the actual loss in ounces of each lot of cheese, together with the percentage loss for each period observed.

In arranging these tables the lots of cheese that were similar in type are placed together. This fact gives much more weight to these figures than to those secured on the smaller lots.

For purposes of convenience the different lots of cheese are divided into three types, depending upon their character:

I. Firm-bodied cheese (export type), of Wisconsin.

II. Sweet-curd type, as represented by the Iowa and Illinois makes.

III. A very moist, soft type, suitable for home trade (Michigan).

Shrinkage of firm, typical Cheddar cheese (type I) cured at different temperatures.

LOT 1.—THOS. JOHNSTON, BOAZ, RICHLAND COUNTY, WIS.

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
10					17	1.26
17			31	1.16	28	1.86
21	17	0.365				
26			50	1.88		
51	37	.796	68	2.55	44	2.83
88	51	1.09	92	3.45	58	3.73
112	54	1.16	100	3.76	65	4.19
160	58	1.18	123	4.55	96	6.13
Weights of cheeses when received	299 lbs. 6 ozs.		166 lbs. 4 ozs.		97 lbs. 1 oz.	
Number of cheeses weighed	9		5		3	

Shrinkage of firm, typical Cheddar cheese (type I), etc.—Continued.

LOT 2.—H. J. NOYES, MUSCODA, GRANT COUNTY, WIS.

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 58° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
10	....	....	....	....	14	0.912
16	....	....	16	1.07	26	1.69
19	17	0.374	....	....	....	....
24	....	....	28	1.87	....	....
50	35	.77	39	2.61	41	2.67
86	44	.994	63	4.22	49	3.13
110	44	.994	71	4.75	56	3.65
158	50	1.12	82	5.49	78	5.09
Weights of cheeses when received	279 lbs. 12 ozs.		93 lbs. 5 ozs.		95 lbs. 14 ozs.	
Number of cheeses weighed	9		3		3	

LOT 3.—P. H. KASPER, NICHOLSON, WAUPACA COUNTY, WIS.

	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
10	18	0.383	13	0.845	11	0.716
20	....	....	25	1.62	22	1.43
26	34	.724	....	....	....	....
37	....	....	34	2.21	....	....
41	....	....	....	....	38	2.47
74	40	.852	50	3.25	....	....
87	....	....	....	....	56	3.64
97	45	.951	52	3.38	....	....
100	....	....	....	....	60	3.90
145	....	....	68	4.42	78	5.07
163	70	1.46	78	5.06	84	5.46
Weights of cheeses when received	293 lbs. 8 ozs.		96 lbs. 2 ozs.		96 lbs. 1 oz.	
Number of cheeses weighed	9		3		3	

As these three makes of cheese agree quite closely in type, a composite diagram made from the data collected will indicate more nearly the average results which may be expected than where they are considered separately. The actual losses observed in the three foregoing lots of Wisconsin cheese were first charted individually and from these an average curve constructed, which is represented in figure 4. In this and following figures the losses are shown for a period of ninety days only, so that the figures would be on the same scale.

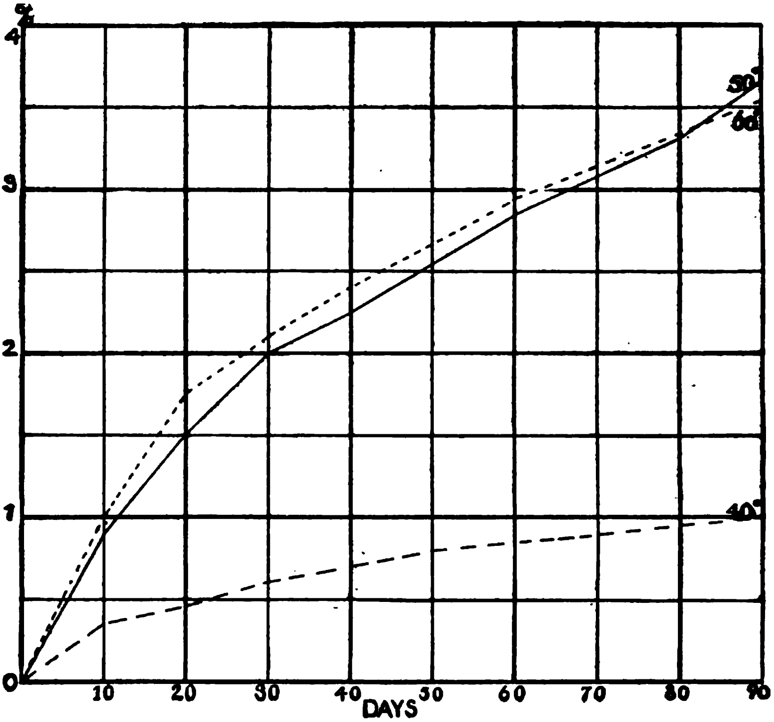

FIG. 4.—Weight losses—type I, cured at different temperatures.

Shrinkage of sweet-curd cheese (type II) cured at different temperatures.

LOT 1.—E. J. HODGES, UNION, IOWA.

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
7	35	0.774	23	0.933	12	0.852
17					22	1.56
20			35	1.42		
34	51	1.13			32	2.27
37			63	2.55		
71	55	1.21			61	4.33
74			76	3.07		
94	69	1.59	86	3.47	66	4.68
145			103	4.16	78	5.54
163	85	1.88				
Weight of cheeses when received	282 lbs. 7 ozs.		154 lbs. 7 ozs.		88 lbs. 1 oz.	
Number of cheeses weighed	9		5		3	

Shrinkage of sweet-curd cheese (type II) cured at different temperatures—Continued.

LOT 2.—J. B. GILBERT & CO., STERLING, ILL.

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
10	22	0.533	26	1.11	15	1.08
20			42	1.80	26	1.88
26	34	.821				
37			58	2.41	40	2.89
74	50	1.21	83	3.56	56	4.13
97	62	1.50	92	3.94		
100					63	4.56
145			110	4.71	73	5.29
163	74	1.79				
Weight of cheeses when received	258 lbs.		145 lbs. 13 ozs.		86 lbs. 4 ozs.	
Number of cheeses weighed	9		5		3	

A composite curve of this type of cheese was made in a similar manner to that noted in type I (fig. 4), and is represented in figure 5.

Shrinkage of soft, moist, home-trade cheese (type III) cured at different temperatures.

LOT 1.—A. H. BARBER & CO., MERRILL, MICH.

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
10	6	0.30	6	1.15	5	1.05
20			10	1.92	7	1.47
26	10	.50				
37			12	2.30		
41					10	2.10
74	14	.70	16	3.07	15	3.15
100	20	1.00	18	3.46	19	3.99
145			21	4.38	28	5.88
Weight of cheeses when received	125 lbs. 6 ozs.		32 lbs. 8 ozs.		29 lbs. 12 ozs.	
Number of cheeses weighed	4		1		1	

Shrinkage of soft, moist, home-trade cheese (type III), etc.—Continued.

LOT 2.—A. H. BARBER & CO., MERRILL, MICH.

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
4	2	0.10	....	....	....	....
10	....	....	4	0.837	4	0.840
20	....	....	8	1.67	7	1.47
26	13	.65	....	....	....	....
37	....	....	11	2.30	....	....
41	....	....	....	....	10	2.10
74	17	.85	14	2.92	16	3.36
100	28	1.40	18	3.76	20	4.20
145	....	....	21	4.38	30	6.30
Weight of cheeses when received	121 lbs. 11 ozs.		29 lbs. 14 ozs.		29 lbs. 12 ozs.	
Number of cheeses weighed	4		1		1	

LOT 3.—A. H. BARBER & CO., MERRILL, MICH.

	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
10	42	0.538	32	0.88	17	0.814
20	....	....	76	2.08	28	1.34
37	73	.935	102	2.79	44	2.10
74	82	1.05	124	3.39	68	3.25
100	95	1.21	133	3.67	73	3.49
Weight of cheeses when received	487 lbs. 14 ozs.		228 lbs.		13 lbs. 7 ozs.	
Number of cheeses weighed	15		7		4	

LOT 4.—A. H. BARBER & CO., MERRILL, MICH.

	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
7	23	0.676	9	0.928	6	1.24
17	....	....	....	....	11	2.28
20	....	....	17	1.75	....	....
34	39	1.14	23	2.37	18	3.73
71	47	1.37	28	2.88	29	6.02
97	55	1.62	38	3.92	32	6.64
145	....	....	....	....	39	8.09
Weight of cheeses when received	219 lbs. 7 ozs.		60 lbs. 9 ozs.		30 lbs. 9 ozs.	
Number of cheeses weighed	7		2		1	

In the four preceding lots of cheese considerable difference in rate of loss will be noticed. This is explained, when it is considered that these lots were exposed during transit period to higher temperatures for varying periods of time, as follows: Lot 1, seventeen days; lot 2, fourteen; lot 3, twelve; and lot 4, seven days.

Figure 6 shows a composite curve of the Michigan cheese, which was made in a similar manner to those shown in figures 4 and 5.

GENERAL SUMMARY OF LOSSES AT DIFFERENT TEMPERATURES.

In figures 4, 5, and 6 the average curves showing losses of the different types of Cheddar cheese are shown. Frequently the cheese maker wishes to know what these losses would be for stated intervals at different temperatures. With the data at our command it is impossible to answer definitely this question, because of the varying conditions which surrounded the cheese during the transit period, but in the table below the losses which occurred after the cheeses were installed in the respective curing rooms are presented for consideration. In this table the average losses for ten days or multiples thereof

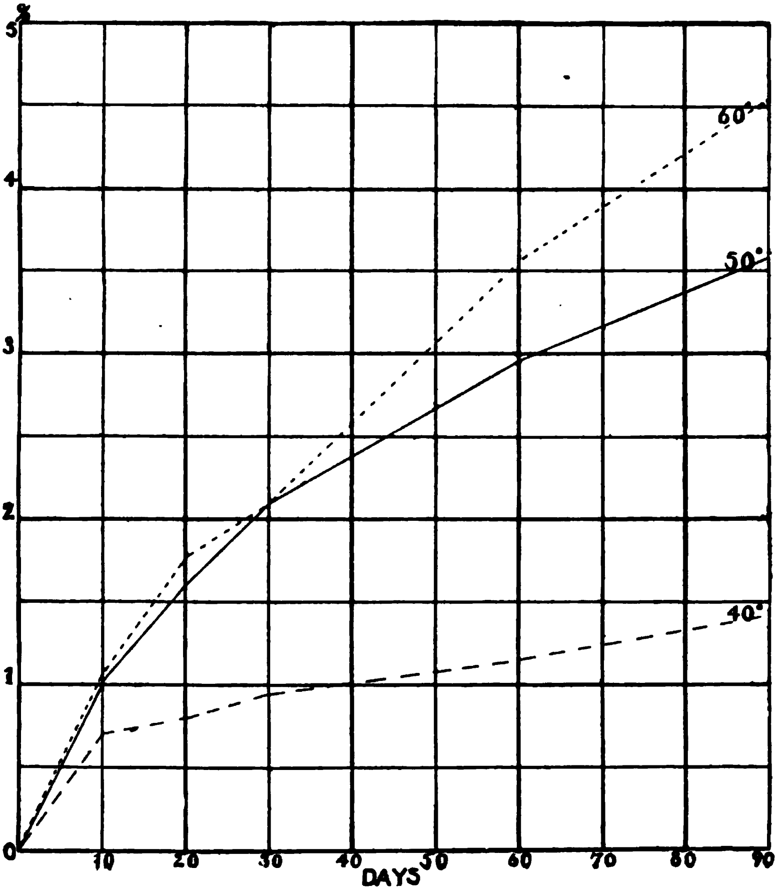

FIG. 5.—Weight losses—type II, cured at different temperatures.

are given. In constructing this table the data for each lot of cheese were first charted. From the curves so obtained the losses of each lot for the periods of ten, twenty, thirty, sixty, and ninety days were

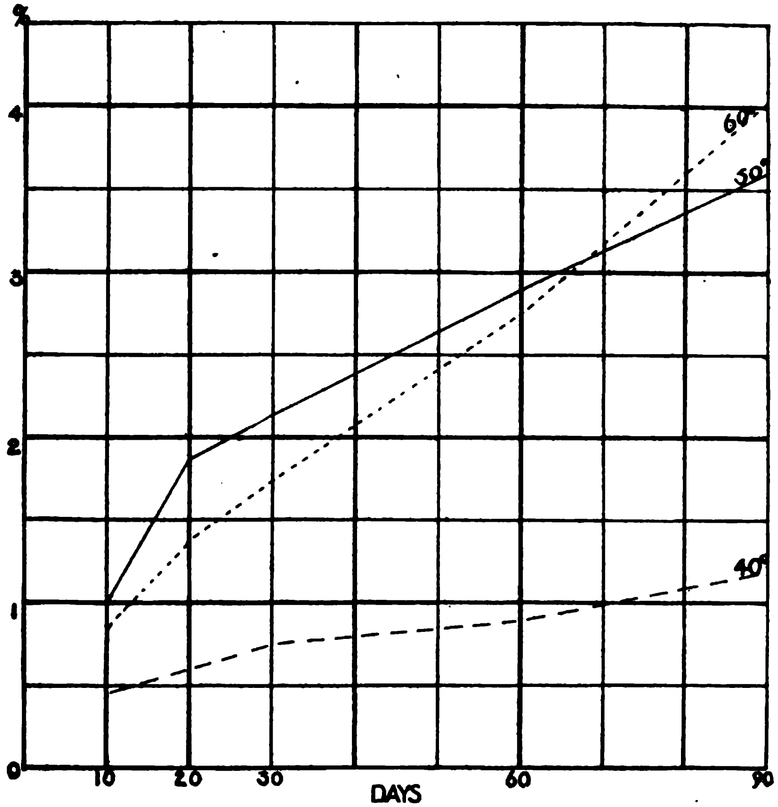

FIG. 6.—Weight losses—type III. Michigan cheese.

taken from the above charts by observation. An average of these losses for each type of cheese is given in the following table:

Losses at different periods in cheese cured at different temperatures.

Days.	Type I (typical Cheddar).			Type II (sweet-curd).			Type III (soft).		
	27 cheeses tested at 40°.	11 cheeses tested at 50°.	9 cheeses tested at 60°.	9 cheeses tested at 40°.	5 cheeses tested at 50°.	5 cheeses tested at 60°.	30 cheeses tested at 40°.	11 cheeses tested at 50°.	7 cheeses tested at 60°.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
10.........	0.38	0.92	0.96	0.69	1.02	1.05	0.49	0.92	0.85
20.........	.44	1.48	1.74	.82	1.60	1.77	.64	1.89	1.39
30.........	.58	2.00	2.05	.96	2.10	2.29	.84	2.35	1.75
60.........	.83	2.87	2.95	1.15	2.97	3.67	.98	2.98	2.77
90.........	1.00	3.64	3.57	1.42	3.60	4.47	1.21	3.55	4.02

As the number of cheeses of the different types cured at the various temperatures were not the same, the percentage losses given in the above table for the varying periods noted are therefore not entitled to equal weight. The smallest number of cheeses were those exposed at

60°, while nearly 60 per cent of the entire lot were kept at 40°. This gives much greater weight to the figures presented in the 40° series.

In the table it will be observed that there are some apparent discrepancies, especially in the case of the 50° and 60° lots of type III. These discrepancies are undoubtedly explained by the fact that this type of cheese, which was the moistest of the whole lot in the beginning, lost more during the longer transit period, and hence the evaporation was less than in other types after being placed in cold storage.

(1) The losses sustained by the different lots were very much less at 40° F. than at either of the other two temperatures. For a ninety-day period the losses of the 40° cheese ranged from 1 to 1.4 per cent, while the 50° and 60° product shrunk from 3.4 to 4.5 per cent for the same time. In other words, by the use of the lower temperature for curing practically two-thirds of the losses which occurred at the temperatures of 50° and 60° were prevented. If these results are compared with what happens under ordinary factory conditions, the loss at these low temperatures for a period of ninety days (the minimum curing period recommended) will not be more than one-fourth of that which obtains under average factory conditions when the cheeses are held for a period of about twenty days. The saving for any such factory making 500 pounds of cheese daily would amount to at least 15 pounds of cheese (or $1.50) per day as an average for the season, and considerably more than this for cheese made during hot weather. This saving in itself would go far toward meeting the extra expense of lower temperature curing, even if the product was no better than that cured at higher temperatures.

(2) The differences between the cheese cured at 50° and 60° are not so marked as between 50° and 40°. It is quite probable, as before mentioned, that the 50° room was somewhat drier than the 60° (as shown by the lessened mold growth), and hence the rate of loss was abnormally increased in this room. This would tend to bring the two curves nearer together.

(3) If the firm Wisconsin type is compared with the softer variety, as shown in types II and III, it appears that the losses are considerably less, especially at the higher temperatures, although this difference is not so observable at 40°.

(4) The above data presented show a marked saving in losses where the cheese was cold cured, but in these experiments it must be remembered that the cheese was subjected to higher temperatures during transit, and hence dried out somewhat more than would have occurred if put in storage as soon as removed from the press; also, that this cheese was box-cured, and therefore under conditions which prevented rapid evaporation. Under other conditions the losses would have been greater than represented here, and the difference in the rate of loss between the different lots wider than reported above. This would still further increase the saving.

B. INFLUENCE OF SIZE AND FORM OF CHEESE ON SHRINKAGE.

In order to study the influence of size of package on shrinkage during curing, lots of two different sizes were purchased from the same source. These two sizes were the customary daisy type, 13 inches in diameter and 3½ inches high, weighing about 20 pounds apiece, and the newer type of print cheese, put up in 10-pound blocks (10 by 10 by 2⅝ inches). These cheeses were of the usual Wisconsin Cheddar type, although a little firmer than the Wisconsin flats used in these experiments. On account of this difference in type, it is impossible to compare these cheeses directly with the larger 30-pound size.

In the following tables are presented the actual and percentage losses which were noted in the two lots of cheese (daisies and prints) which were purchased from the La Crosse Cheese and Butter Company, of La Crosse, Wis.:

Shrinkage of different-sized cheeses cured at different temperatures.

LOT 1.—PRINTS (10 POUNDS).

Curing period (days).	Loss in weight at different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
7	....	....	1	0.62	2	1.23
10	3	0.371	....	....	....	....
16	....	....	3	1.82	....	....
24	....	....	....	....	4	2.46
41	7	.865	5	3.1	8	4.92
78	11	1.35	9	5.59	14	8.64
100	14	1.73	10	6.2	16	9.88
167	21	2.61	12	7.45	18	11.11
Weights of cheeses when received	50 lbs. 8 ozs.		10 lbs. 1 oz.		10 lbs. 2 ozs.	
Number of cheeses weighed	5		1		1	

LOT 2.—DAISIES (20 POUNDS).

	Ounces.	*Per cent.*	*Ounces.*	*Per cent.*	*Ounces.*	*Per cent.*
7	....	....	35	0.673	25	1.14
16	38	0.527	72	1.38	....	....
24	....	....	....	....	41	1.96
30	66	.916	....	....	....	....
41	....	....	103	1.98	65	3.11
78	90	1.25	128	2.46	89	4.26
100	101	1.40	134	2.58	97	4.64
149	136	1.89	148	2.85	118	5.65
Weights of cheeses when received	449 lbs. 15 ozs.		325 lbs. 8 ozs.		130 lbs. 9 ozs.	
Number of cheeses weighed	24		17		7	

In figures 7 and 8 are represented, graphically, the losses observed in the smaller sizes of cheeses (10 and 20 pound varieties). It will be noted that these losses at the different temperatures are greater as the temperature increases, and that the differences between the various temperatures are more marked as the relative size of the cheese diminishes.

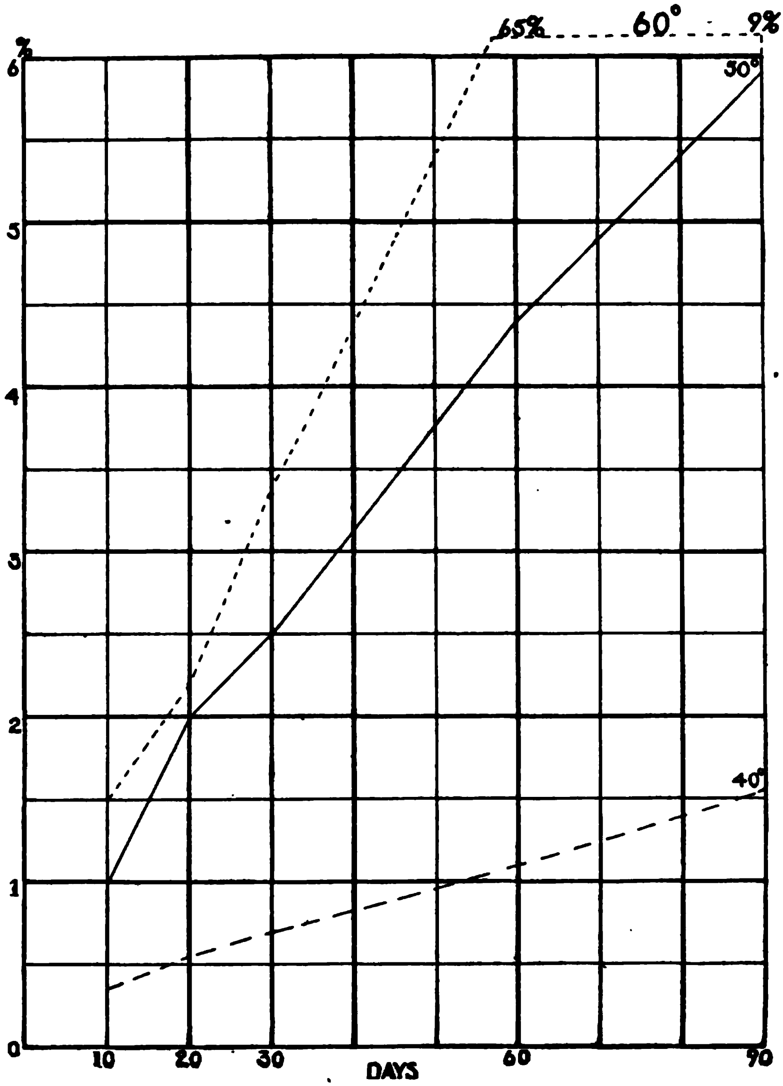

FIG. 7.—Weight losses. 10-pound prints.

In order that a comparison may be made between different sizes of cheeses at the same temperatures, and the losses at these respective temperatures compared with each other, the foregoing data are rearranged in figures 9, 10, and 11, so as to show the rate of losses of the different sizes of cheeses at the different temperatures.

From these curves it is evident that at 40° (fig. 9) the loss was practically the same in both sizes of the cheeses. This is probably because the relative humidity at this temperature was practically 100 per cent, and therefore in a saturated atmosphere the rate of evaporation would be reduced to a minimum, regardless of the size of the cheese.

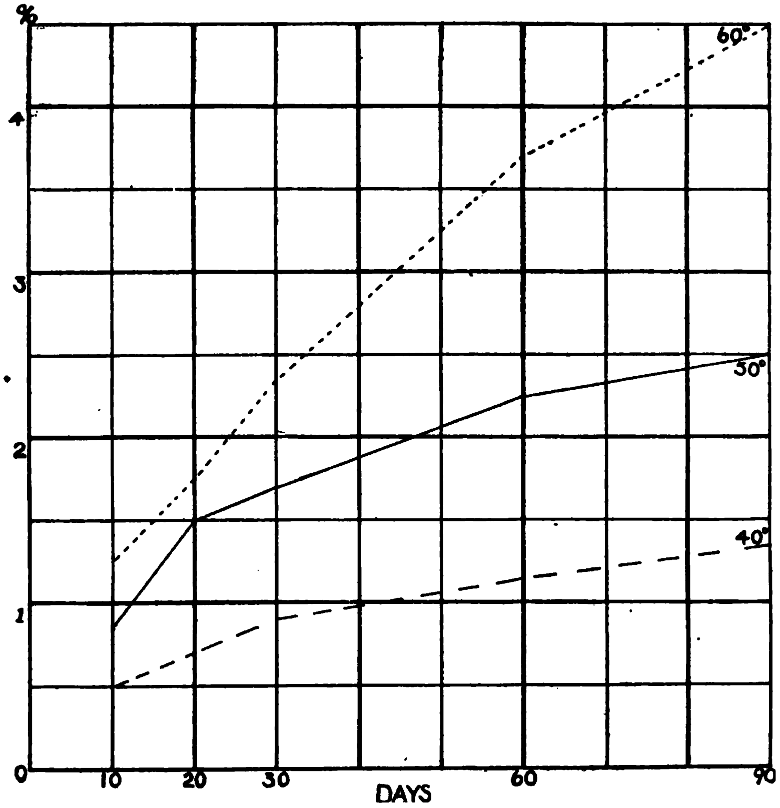

FIG. 8.—Weight losses. 20-pound "Daisies."

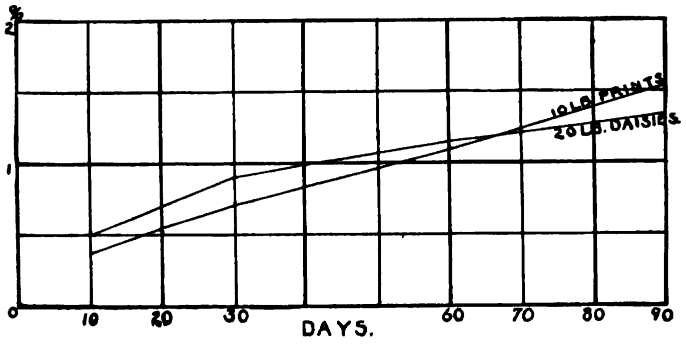

FIG. 9.—Weight losses. Small cheeses. Cured at 40° F.

It must be remembered that the entire loss in weight during the curing of cheese is not due to evaporation. A cheese in curing is constantly breathing out carbon dioxide the same as any living organism, due to the development of microorganisms (bacterial growth within the cheese as well as molds on surface). Aside from these biological factors, it has recently been shown by Van Slyke and Hart[a] that profound proteolytic decompositions also give rise to an appreciable amount of CO_2. With cheese at 60° F., in which external mold growth was suppressed, they found a loss of approximately one-fourth of 1 per cent in ninety days. In our cold-cured cheese, copious mold development occurred, and hence the losses of carbon from the cheese due to this growth would be considerably greater than if no such growth occurred. With the nearly uniform rate of shrinkage shown in these cold-cured cheeses, regardless of size, it is quite problematical whether this loss in weight may not be chiefly due to the operation of the foregoing factors. If this is so, we may consider

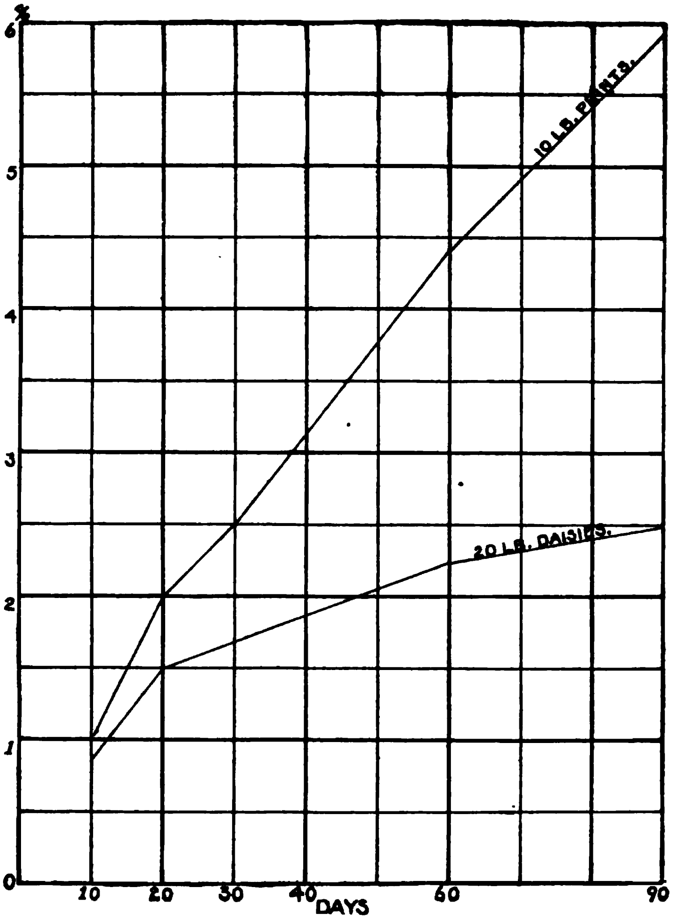

FIG. 10.—Weight losses. Small cheeses. Cured at 50° F.

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[a] Bul. No. 231, New York Agricultural Experiment Station, p. 36.

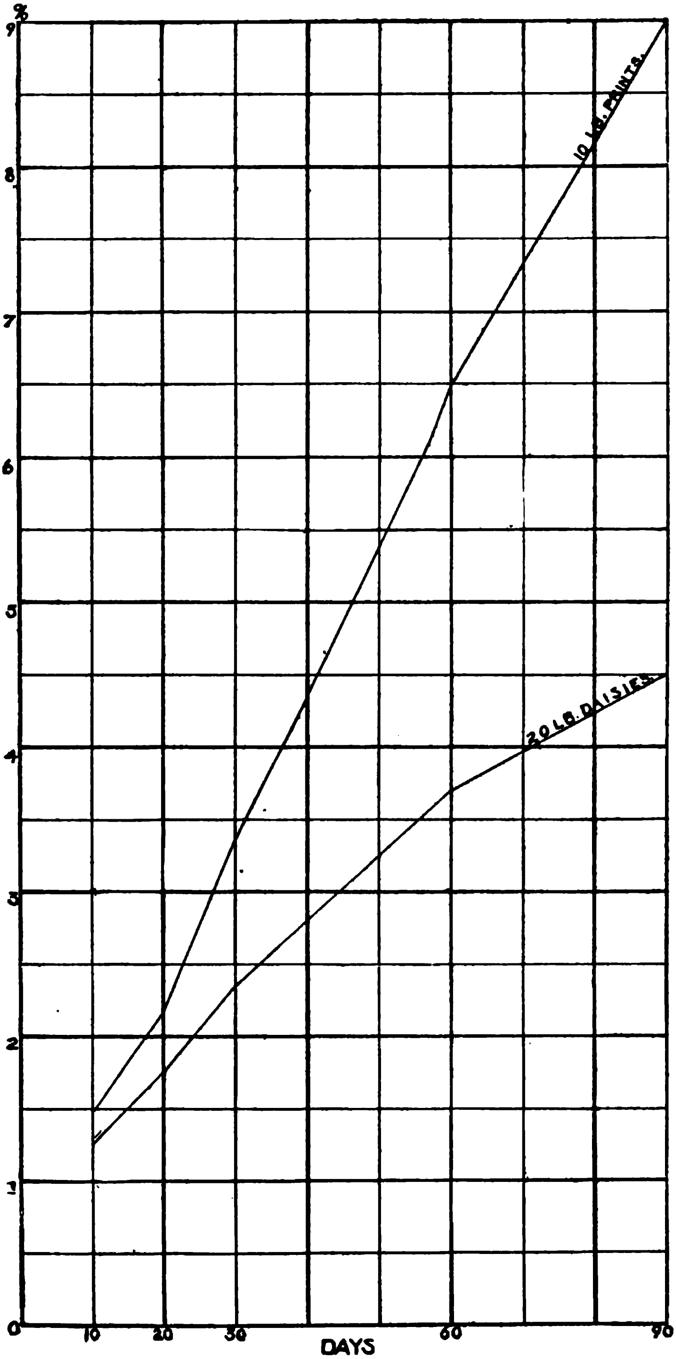


FIG. 11.—Weight losses. Small cheeses. Cured at 60° F.

NOTE.—Figures 9, 10, and 11 should be compared as showing the relative loss of cheeses of different sizes.

such losses as absolutely unavoidable under normal conditions, for the action of microorganisms which can not be suppressed will inevitably result in the production of some volatile products.

At the temperatures of 50° and 60°, where the relative humidity was below saturation, the factor of evaporation is apparent and is inversely related to the size of the cheese. From a practical point of view, it is worth noting that the losses in both sizes of cheeses cured at 60° are approximately 50 per cent more than they are in the cheese ripened at 50° F. (See Figs. 10 and 11.)

C. INFLUENCE OF PARAFFINING CHEESE ON SHRINKAGE DURING CURING.

Within the last few years the custom of coating the cheese with an impervious layer has been suggested, with the object mainly of preventing the development of mold. For this purpose paraffin has been found to be the most suitable agent. The application of such a layer to the cheese not only prevents the growth of mold spores by excluding the air, but materially retards the rate at which the cheese loses its moisture. Paraffined cheese then dries out much more slowly than the untreated product, and the application of this method is of particular service in the handling of the smaller types of cheeses, which have a relatively larger superficial area exposed to the air.

To study the effect of this method of treatment at different temperatures, a number of the smaller sizes of cheeses (daisies and 10-pound prints) were taken from the same make and part of them covered with paraffin. These were divided into three lots and placed in the different curing rooms, where they were held for a period of several months.

In the following table are recorded the data as to the percentage loss in both the paraffined and unparaffined (control) lots:

Shrinkage in paraffined and unparaffined cheese cured at different temperatures.

10-POUND PRINT CHEESE.

Curing period (days).	Loss in weight for different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Unparaffined.	Paraffined.	Unparaffined.	Paraffined.	Unparaffined.	Paraffined.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7			0.62	0.24	1.23	0.603
10	0.37	0.495				
16			1.82	.84		
24					2.46	1.8
41	.865	1.06	3.1	1.45	4.92	2.77
77	1.35	1.48	5.6	2.9	8.64	3.01
100	1.73	1.88	6.2	3.5	9.88	3.62
Number of cheeses tested	5	17	1	5	1	5

Shrinkage in paraffined and unparaffined cheese cured at different temperatures—Cont'd.

20-POUND DAISIES.

Curing period (days).	Loss in weight for different periods of storage.					
	At 40° F.		At 50° F.		At 60° F.	
	Unparaffined.	Paraffined.	Unparaffined.	Paraffined.	Unparaffined.	Paraffined.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7			0.673		1.14	0.317
14	0.527	0.466				
16			1.38	0.609		
24					1.96	1.58
30	.916	1.10				
41			1.98	.914	3.11	2.54
77	1.25	1.71	2.46	1.65	4.26	3.17
100	1.40		2.58	2.0	4.64	3.49
Number of cheeses tested	24	4	17	1	7	1

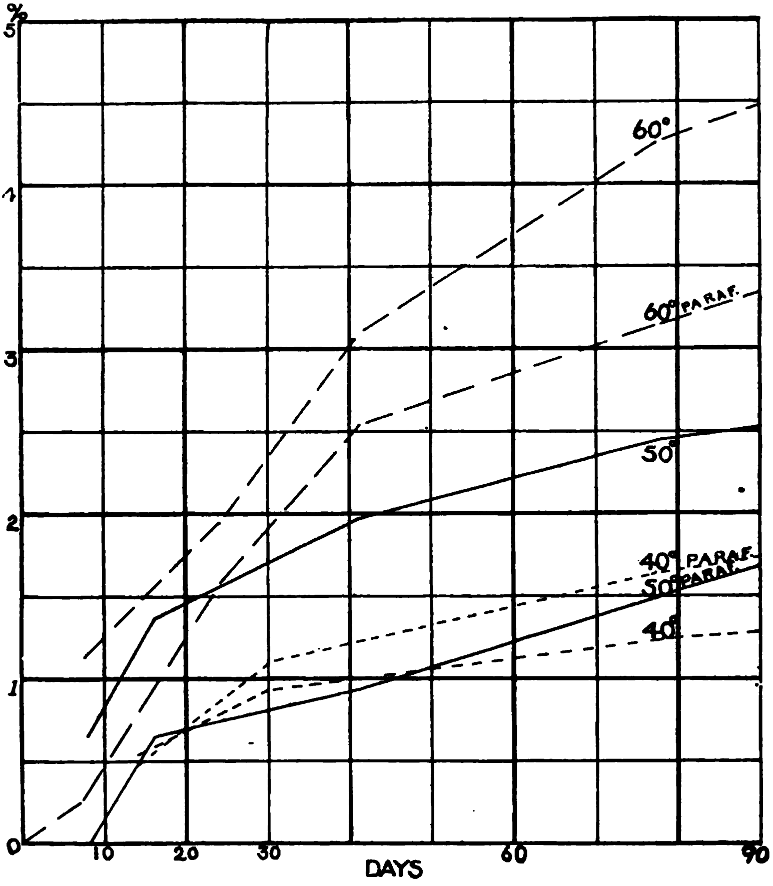


FIG. 12.—Weight losses. 20-pound Daisies. Paraffined.

In order to permit a more ready comparison of the above data, the same are presented in graphical form in figures 12 and 13. At 60° F. the application of paraffin resulted in reducing the losses to less than one-half of that which occurred in the unparaffined lot. This difference is naturally more observable in the smaller-sized cheeses (prints). At

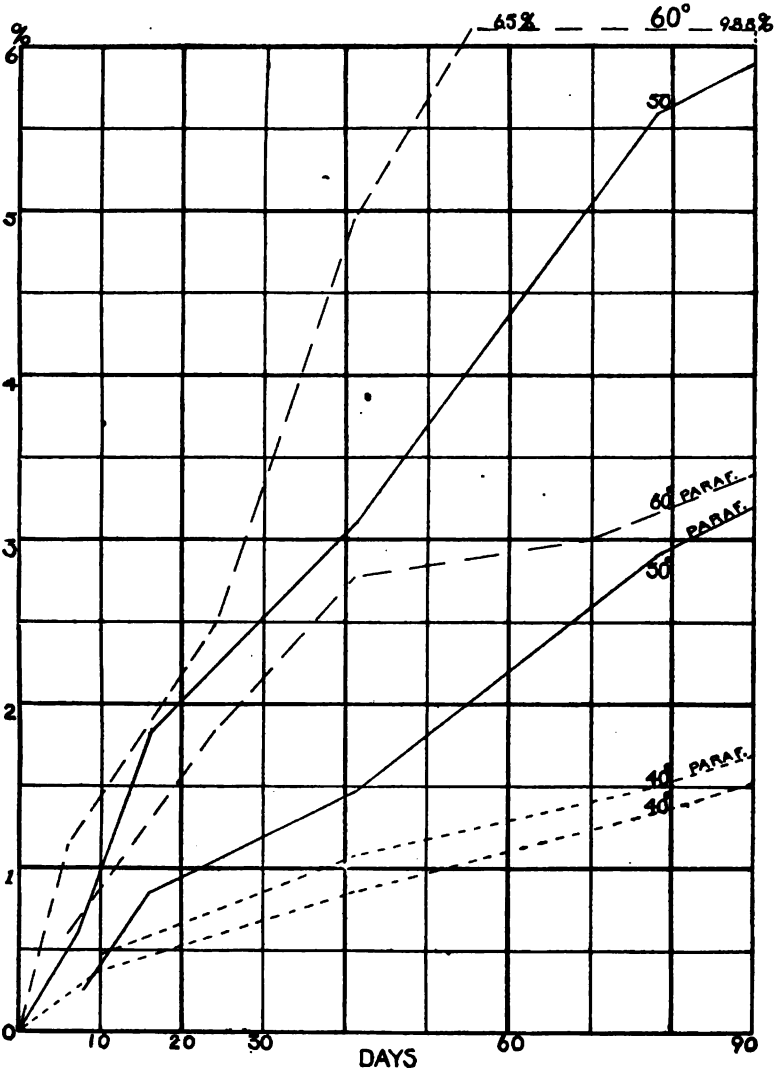


FIG. 13.—Weight losses. 10-pound prints. Paraffined.

50° this ratio was slightly diminished, but was in the same general direction. At 40° a peculiarity is observable in both the print and the daisy size, in that the paraffined cheese lost a trifle more than the unparaffined lot. We do not think this apparent paradox can be explained on the basis of errors in weighing, as there were five unparaffined and seventeen paraffined print cheeses and twenty-four unparaffined and four paraffined 20-pound cheeses in these experiments. Also the weighings of these cheeses were made at frequent intervals and in every case the same relation was observed. Further experiments are in progress to test the accuracy of these observations.

In the paraffined cheese at 40° the losses were reduced practically to a minimum, as was also the case with the unparaffined at this temperature. As evaporation would certainly be lessened in the paraffined lot, the uniformity of loss between these and the unparaffined still further substantiates the view advanced earlier that these losses are not so much due to shrinkage from evaporation as they are to metabolic activities of organisms and possibly chemical transformations within the cheese.

PART II.—EFFECT OF TEMPERATURE ON QUALITY OF CHEESE.

A. COURSE OF CURING AT DIFFERENT TEMPERATURES.

Originally it was planned to have the cheese judged by commercial experts, but it was found impossible to arrange for a sufficiently large number of such tests to closely follow the progressive changes which occurred in the course of the ripening of the cheese. Hence, in addition to the examinations made by the jury of commercial experts, the cheese was carefully scored at Waterloo by Mr. Baer at frequent intervals. The full details of these examinations, which include numerical and descriptive scores, as well as the intrinsic value of the cheese at the different periods when it was examined, are presented in the appendix (p. 57.)

COURSE OF RIPENING IN TYPE I.

This type was represented by four different lots of Wisconsin cheese. All of them were well-cooked, firm-bodied, slow-ripening cheese that may be regarded as typical Cheddars. In one case the milk from which the cheese was made was evidently tainted, as the cheese was slightly off at the outset.

The results of these periodical scores by Mr. Baer show that good cheese was produced at all temperatures in the first three lots. Naturally that cured at 60° developed more rapidly than the goods cured at lower temperatures, but it should be noticed that even at this temperature some of the firm-textured cheese went off in five months. At 50° and 40° the cheese was about six weeks to two months behind the 60° in development, but in time it reached as high as the 60° lot, and generally of a better quality, and kept this maximum condition much longer than the 60°. This enhanced keeping quality was more pronounced at 40° than at 50°.

In the lot made from tainted milk (La Crosse, p. 58) the imperfect condition was pronounced at all temperatures, but was more prominent at 60° than below.

In studying the detailed scores by Mr. Baer, presented in the appendix, it is possible to combine the numerical scores of the four different lots of Wisconsin cheese belonging to the same type and so obtain a set of averages, as to flavor, texture, and price, which indicate clearly the progress of the curing of these various lots at the different temperatures. In the following table these summaries are included:

Summary of scores and values of cheese in type I (firm export type).

Age (months).	Flavor (standard 45).			Texture (standard 30).			Price (standard 13 cents).		
	40°.	50°.	60°.	40°.	50°.	60°.	40°.	50°.	60°.
1	33.3	34.3	35.8	23.3	22.3	24.3	....	....	....
2	37	38.3	39	26	25.8	26.8	10	10.5	10.8
3	41.5	42.3	42.3	28.6	28.5	29	11.81	12.4	12.4
5	43	41	39.5	29.3	29	27.5	12.69	12	11.44
8	43.8	....	....	29	....	....	12.75	....	....

Flavor.—The variation in flavor observed at the different temperatures is more marked than any other characteristic. This range in flavor is also shown graphically in figure 14. From this it appears

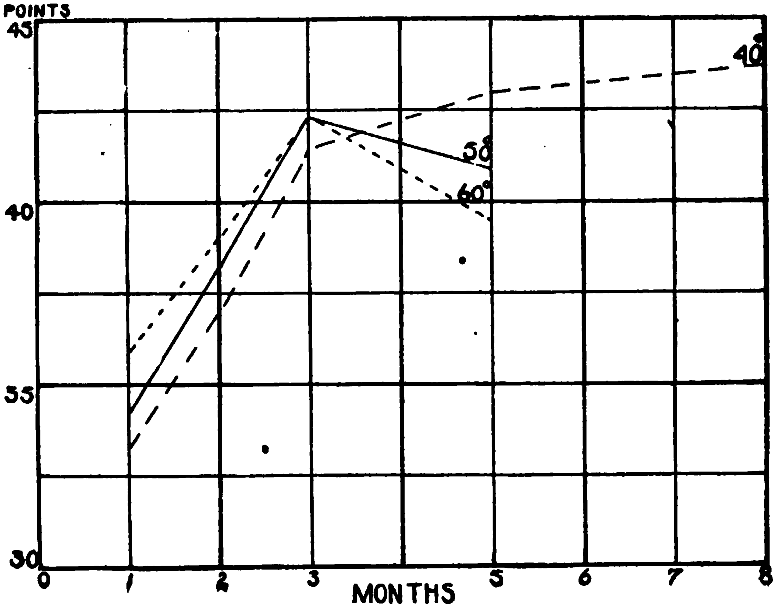


FIG. 14.—Flavor for type I.

that at the higher temperatures the flavor is more developed during the earlier ripening stages, but as the cheese increases in age the quality of the flavor at the higher temperatures deteriorates more rapidly than in the cold-cured goods. At the end of five months the 40° was still improving, and even at this time was higher than at any period with the 50° and 60°. At present writing (eight months), the cold-cured cheese is still of excellent quality, and shows no signs of deterioration.

Texture.—The texture of the cheese followed quite closely a development similar to that noted under "Flavor." In the earlier stages the 60° had the highest score, but it reached its maximum in three months, while the 50° and 40° continued to improve up to the end of the test, and was higher in the 40° at this time than at any time in the 60°. This condition is shown in figure 15.

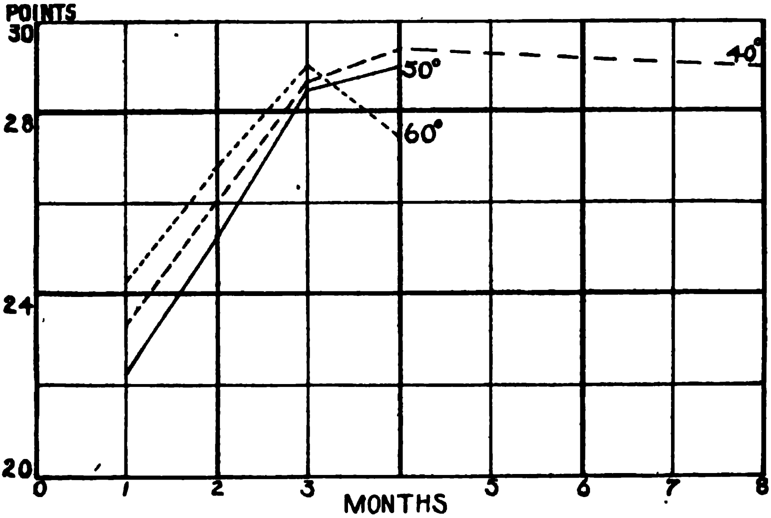
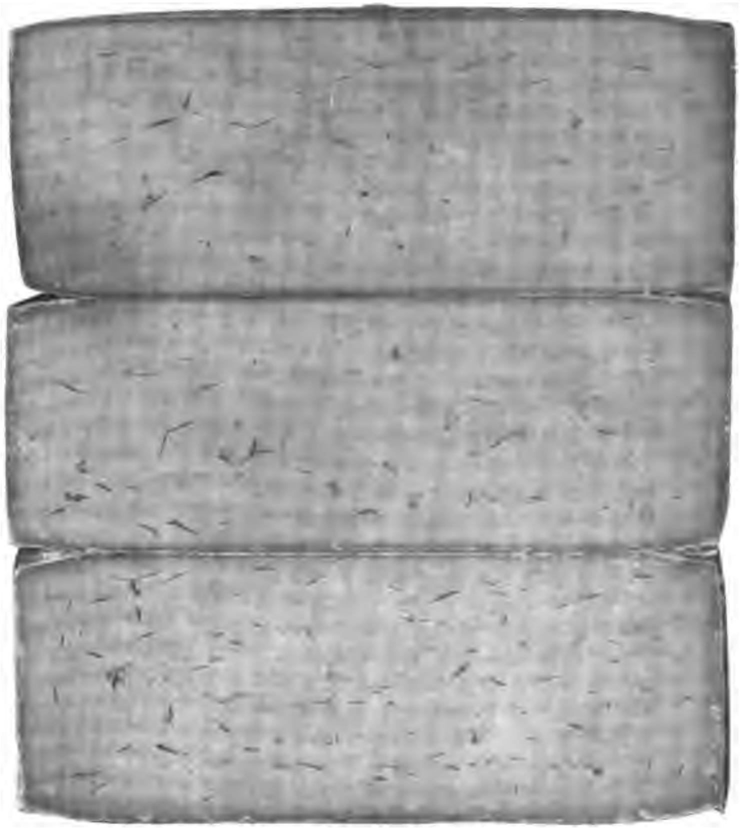


FIG. 15.—Texture for type I.

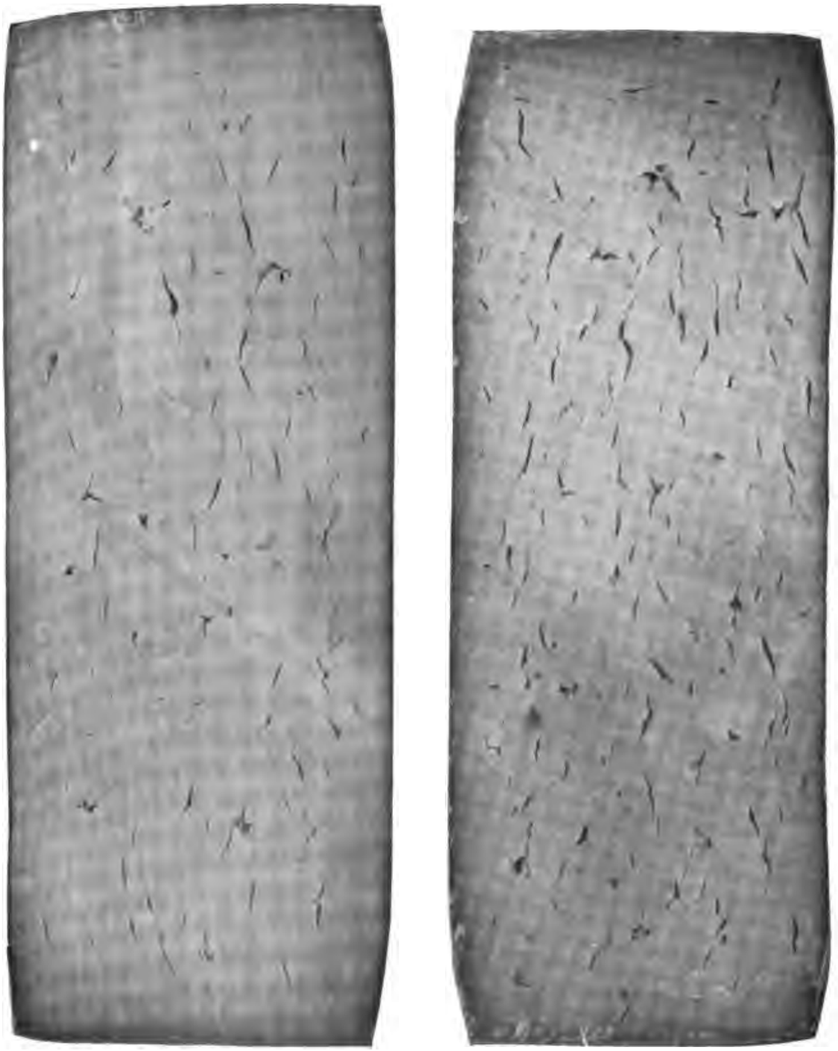
Price.—Figure 16 presents the range in intrinsic value throughout the test. The improved condition with reference to flavor and texture naturally reappears in this commercial standard, in which the 40° cheese, while developing somewhat more slowly, soon passes both the 50° and 60°, and continues to improve while the two latter decline toward the end of the experiment.

The beneficial effect of cold-curing on this firm type of cheese is strikingly apparent from the above data and diagrams. Not only was this cold-cured cheese free from any bitterness or taint incident to the curing process, but it was much improved in texture, as is evident from Plate I, which shows the appearance of cheese made from the same vat but cured at approximately 40°, 50°, and 60° F. When the cheese is cold cured the body is much closer, as the curd particles are subject to more pronounced shrinkage at higher temperatures, which causes the formation of these irregular, ragged cracks. This is per-



THREE CHEESE SECTIONS—TYPE I.

Cheese at top cured at 40°, in middle at 50°, and at bottom at 60°.



TWO VERTICAL CHEESE SECTIONS—TYPE I.

Cheese cured at 40° on left and cheese cured at 60° on right.

haps rendered more obvious in Plates II and III, in which the cheese cured at 40° and 60° are shown. When it is remembered that the results ordinarily obtained in factory curing are not anything like as satisfactory as those shown in the cheese cured at 60°, the improvement in quality, as shown by the texture of the cheese cured by the cold-curing process over that now in vogue, is emphasized still more.

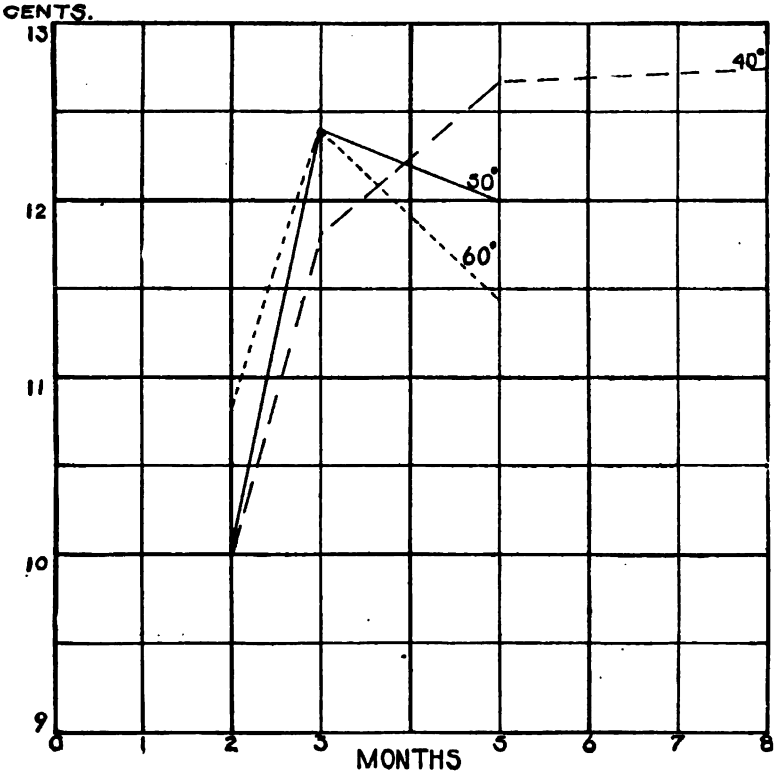


FIG. 16.—Price for type I.

The 50° cheese stands intermediate between the distinctively cold-cured product and that obtained under best present conditions without artificial refrigeration. Emphasis has already been laid upon the fact that a considerable improvement in quality is to be expected where a slight diminution in temperature is secured over that found in the best type of factory curing now in vogue. This system of "cool-curing"—that is, the use of a temperature from 52° to 58° F., as recently advocated by the Canadian authorities[a]—stands midway between the cold-curing process and the system now most frequently in use. The benefits to be gained by this system are evident from the Canadian experiments, in which 480 pairs of cheeses were cured, one of each lot being kept at 52° to 58°, while the other was ripened in an ordinary curing room (61° to 70°). Quoting Mr. Ruddick's paper, he says that "in every case the cool cured (cheese) has been pronounced the best in quality."

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[a] J. A. Ruddick in paper presented at the Ontario Dairymen's Association, January, 1903.

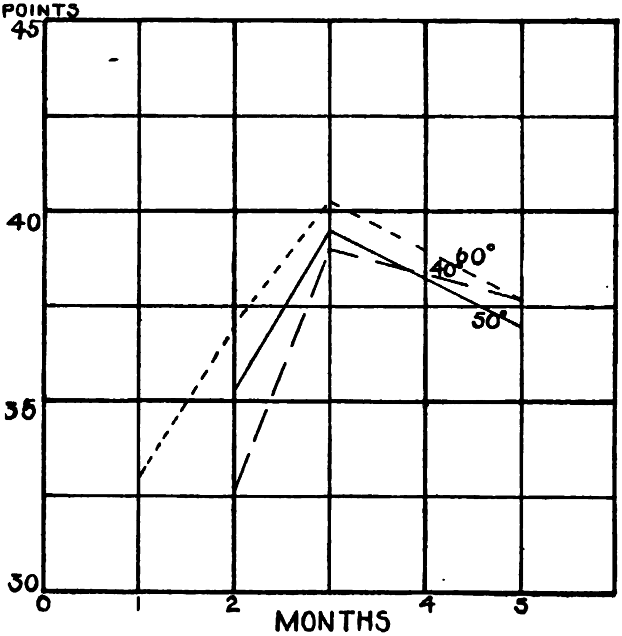


FIG. 17.—Flavor for type II.

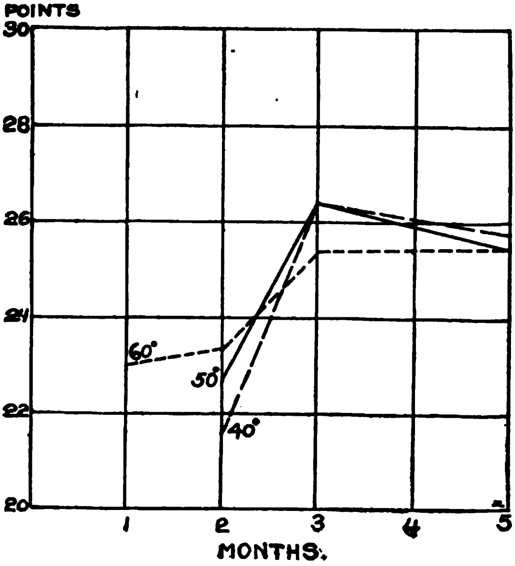


FIG. 18.—Texture for type II.

From the experiments detailed above it appears that further improvement in quality is possible if the curing temperature is still further reduced (40° to 50° F.). It must be remembered in this comparison that the highest temperature we employed is much lower than the average factory curing room. The difference in quality between cold-cured and ordinary-cured cheese would be much greater than that represented in this work.

The cheese of this type at 60° ripened rapidly and showed an excellent quality in all lots but one, which was tainted from the beginning, but they all passed their prime in three months and showed marked deterioration by the end of five months.

With this type of cheese it must be remembered that the quality of the flavor produced at low temperatures is quite different from that found at 60°. Cold-cured cheese possesses a very mild but perfectly clean flavor, together with a solid waxy texture.

COURSE OF RIPENING IN TYPE II.

The cheese in this type is not so uniform in its make-up as that of type I, but it represents that type of American product in which less acid is developed than is found in the normal Cheddar cheese. This cheese is more open in texture and contains a considerable number of mechanical and small Swiss holes as shown in Plate III. The cheese was somewhat low in flavor, due in all probability to the milk and method of manufacture, and not to the curing, as this defect was quite as apparent at the lower temperatures as at 60°.

The Iowa cheese was found to be of only fair quality, but at all ages was better at 40° than at other temperatures, although the difference is considerably less than it was with the firmer Wisconsin type of cheese.

The Illinois cheese was quite similar to the Iowa lot, but the texture of this cheese at 60° was considerably more impaired than that obtained at the lower temperatures.

The following table gives the summary of the scores of these two lots (Iowa and Illinois) taken at intervals during the life of the cheese.

Summary of scores of cheese and values in type II (sweet-curd).

Age in months.	Flavor (standard 45).			Texture (standard 30).			Price (standard 13 cents).		
	40°.	50°.	60°.	40°.	50°.	60°.	40°.	50°.	60°.
1	....	....	35	....	....	22	....	....	9.5
2	37.5	38	36.5	23.5	25	22	10	10.25	9.75
3	40.5	40.5	40	27	26	23.5	11.7	11.13	10.87
5	39	38	35	26	26	25	11	10.75	10.25

In the accompanying diagrams the above tabular data are pictorially represented.

Flavor.—Figure 17 shows the course of development of the flavor. While there was not much difference in the maximum flavor produced (one-half point), still the cold-cured cheese maintained a higher flavor than the 60° throughout the whole experiment. The rapid deterioration of the 60° was especially marked.

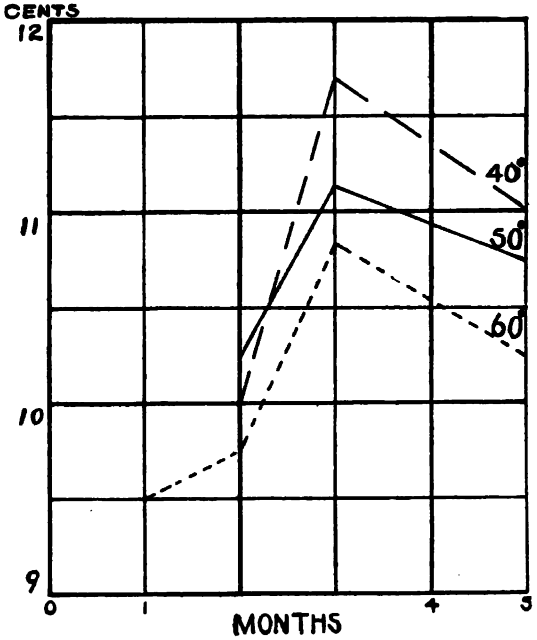


FIG. 19.—Price for type II.

Texture.—In texture, both the 40° and 50° were much superior to the 60° cheese, as is evident from figure 18.

Attention should also be directed in Plate III to the presence of the numerous white specks which only appear in the cold-cured cheese.

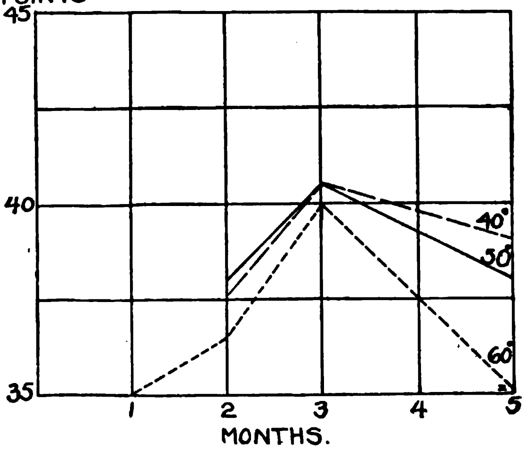
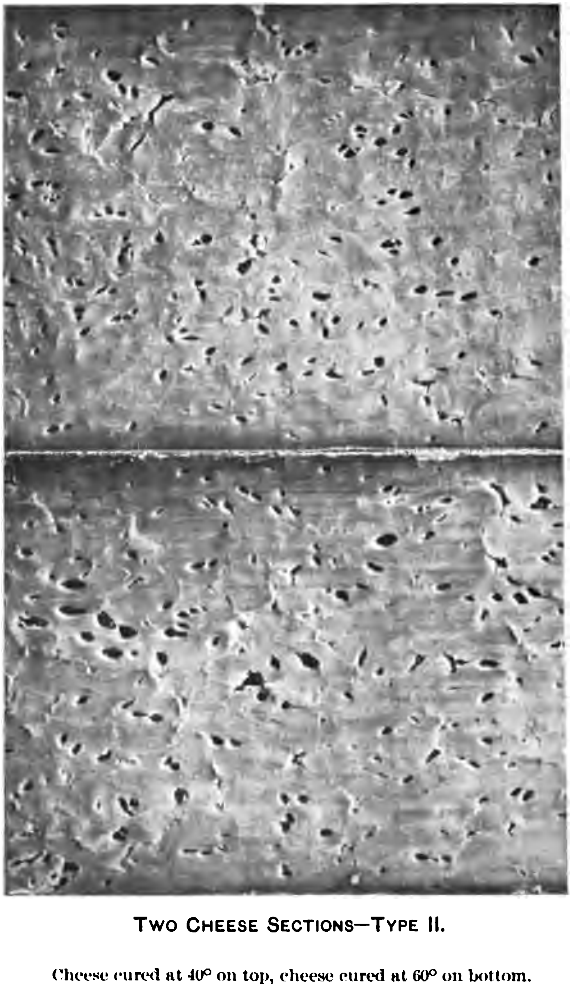


FIG. 20.—Flavor for type III.



TWO CHEESE SECTIONS—TYPE II.

Cheese cured at 40° on top, cheese cured at 60° on bottom.

These small spots have always been found in our cheese cured at temperatures of 50° and below.

Price.—The commercial standard shows again the improvement in value and the maintenance of this improved condition for a longer period of time, as is evident from figure 19.

COURSE OF RIPENING IN TYPE III.

This type represents the softer make of cheese intended for home trade, and one which cures more quickly, and therefore does not keep as long as the firmer Cheddar type. This type is represented by four different lots of Michigan cheese made at the same factory. They were not of standard quality, but were too acid. The first three lots were materially delayed in transit and consequently had undergone considerable change before being cold-cured. From the detailed data given in the appendix (p. 68–70) it is evident that lot 4 was the best, and in this lot the 40° and 50° were both better than the 60°.

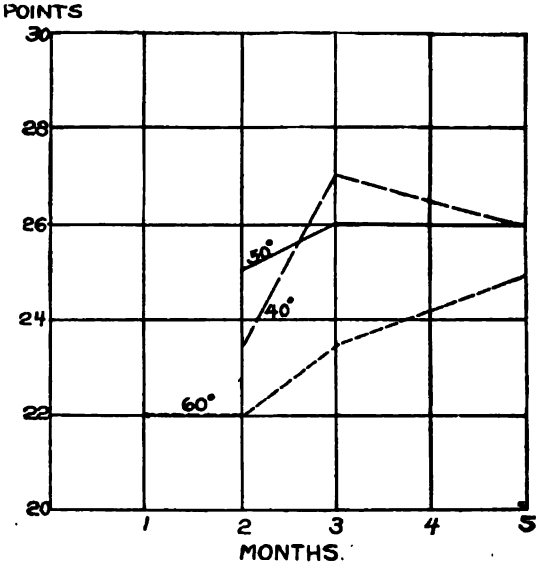


FIG. 21.—Texture for type III.

The average results at the different temperatures are shown in the following table:

Summary of scores and values of cheese in type III (soft Michigan cheese).

Age (months).	Flavor (standard 45).			Texture (standard 30).			Price (standard 13 cents).		
	40°	50°	60°	40°	50°	60°	40°	50°	60°
1	....	....	33	....	....	23	....	....	9
2	32.6	35.3	37	21.7	22.7	23.3	9.3	10.2	10.5
3	39	39.5	40.2	26.3	26.3	25.3	11.25	11.4	11.5
5	37.7	37	37.7	25.8	25.5	25.5	10.4	10.2	10

Flavor.—In this case the flavor of the 4 lots was poor, only once exceeding 40 points. While the 60° scored higher at one time than the cheese at the other two temperatures, the 40° cheese at five months equaled the flavor of the higher temperature cheese at this time, as is shown in the table and also in figure 20.

Texture.—Figure 21 shows graphically the texture scores presented in the above table. The 60° cheese was materially better in the beginning, but fell slightly behind at the three months' period.

Price.—The difference in price of this cheese at three months was inconsequential, and from this date the cheese at all temperatures fell off rapidly in value as shown in figure 22.

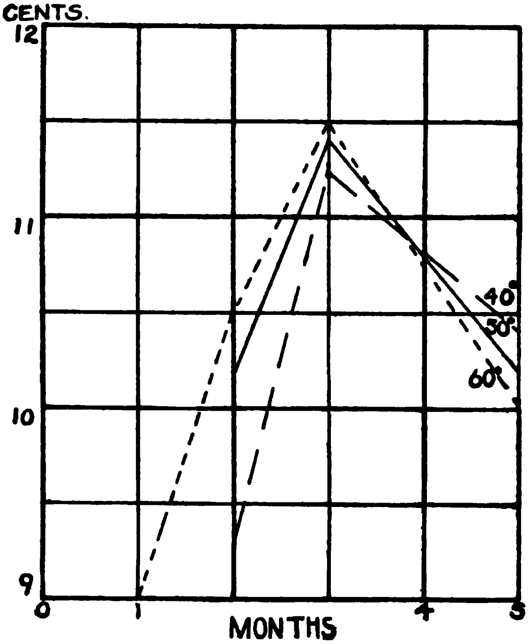


FIG. 22.—Price for type III.

All four lots of these Michigan goods were more or less delayed in transit, although lot four was no more so than some of the cheese in the other types. But with this moist, quick-curing cheese it was much more susceptible to temperature influences, and hence was materially impaired before being put in storage. This condition, taken in connection with the inferior make (high acid), renders this part of the experiment unsatisfactory.

B. EXAMINATION BY COMMERCIAL EXPERTS.

In accordance with the plan originally outlined, the cheese in these experiments was subjected to a close examination by a jury of commercial experts, who had no knowledge as to the previous treatment which the cheese had received. The complete data as to their scores, price assigned, etc., are given in the appendix (p. 57). From these data the following table of averages for each lot of cheese is compiled, including the scores made when the cheese was, respectively, three and five months old:

Comparison of average numerical and commercial scores made by jury when the cheese was 3 and 5 months old.

FIRST JURY TEST (3 MONTHS).

	At 40°.				At 50°.				At 60°.			
	Flavor.	Text.	Color.	Price.	Flavor.	Text.	Color.	Price.	Flavor.	Text.	Color.	Price.
Type I (typical Cheddar).												
Wisconsin:												
T. J., Boaz	41.3	25.8	11.8	12.3	43.3	27.6	14.3	12.6	42.3	28.6	14.0	12.4
H. J. N., Muscoda	42.3	26.3	15	12.2	44.1	27.8	15	12.6	43.6	27.8	15	12.5
P. H. K., Nicholson	44	28.6	14.8	12.8	44	28.3	14.6	12.6	43	26.3	14.2	12.3
La X, La Crosse	43.3	28.6	14.3	12.6	43	28.3	14.3	12.6	42	27.3	14.3	12.3
Total	170.9	109.3	55.9	49.9	174.4	112	58.2	50.4	171.9	110	57.5	49.5
Average	42.7	27.3	14	12.5	43.6	28	14.5	12.6	43	27.5	14.4	12.4
Type II (sweet-curd).												
Iowa:												
E. G. H., Union	42.6	27.6	13.6	12.3	42.6	26.6	13	12.2	42.6	28	13.2	12.4
Illinois:												
J. B. G., Sterling	40.6	25.6	14.3	11.2	40	25	14	11.1	40	24.6	14	11.1
Total	83.2	53.2	27.9	23.5	82.6	51.6	27	23.3	82.6	52.6	27.2	23.5
Average	41.6	26.6	13.9	11.7	41.3	25.8	13.5	11.6	41.3	26.3	13.6	11.7
Type III (soft).												
Michigan:												
A. H. B., Merrill, I	39.6	26.0	13	11.9	40.6	26.6	13	12.2	41	26	13	12.2
A. H. B., Merrill, II	40.6	26.3	12.5	11.8	41.6	27.6	13.3	12.1	40	26.6	12.6	12
A. H. B., Merrill, III	40.3	27.3	13	11.3	42.6	28	13.3	12	40.3	26.3	13	11.5
A. H. B., Merrill, IV	42	28	13.6	12.3	41	26.6	12.6	11.8	42	27	12.6	12
Total	162.5	107.6	52.1	47.3	165.8	108.8	52.2	48.1	163.3	105.9	51.2	17.7
Average	40.6	26.9	13	11.8	41.4	27.2	13	12	40.8	26.5	12.8	11.9

Comparison of average numerical and commercial scores made by jury when the cheese was 3 and 5 months old—Continued.

SECOND JURY TEST (5 MONTHS).

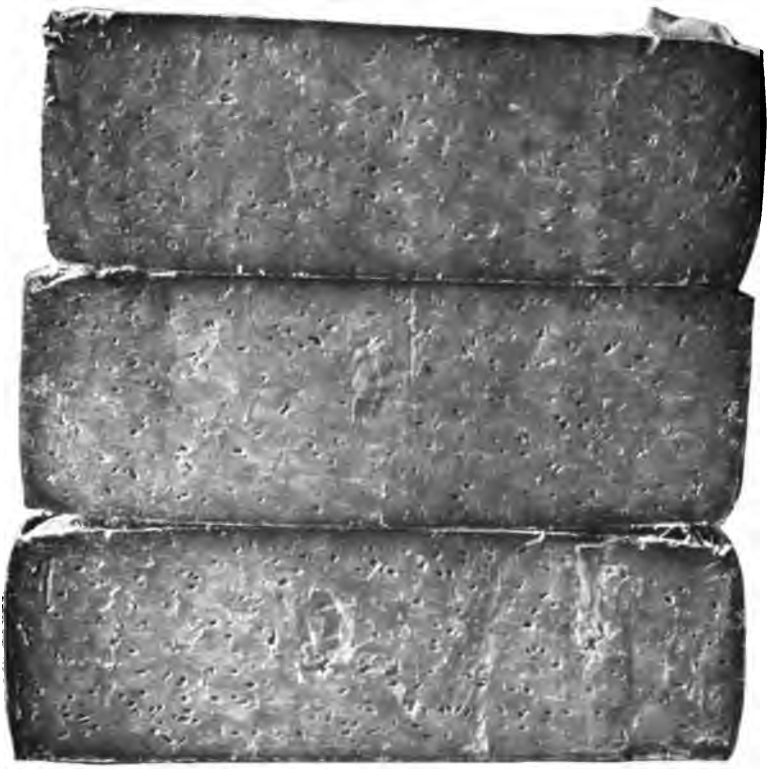
	At 40°.				At 50°.				At 60°.			
	Flavor.	Text.	Color.	Price.	Flavor.	Text.	Color.	Price.	Flavor.	Text.	Color.	Price.
Type I (typical Cheddar).												
Wisconsin:												
T. J., Boaz	43.5	28.5	15.0	12.8	40.0	28.5	15.0	12.5	38.5	28.5	15.0	12.4
H. J. N., Muscoda	44	29.5	15	13	43.5	28.5	15	12.9	43	28	15	12.8
P. H. K., Nicholson	41	28	15	12.6	41.5	28.5	15	12.6	42	28.5	15	12.8
La X, La Crosse	41	27.5	13.5	12.1	40	26.5	12.5	11.9	35	25	14	11
Total	169.5	113.5	58.5	50.5	165	112	57.5	49.9	158.5	110	59	49
Average	42.4	28.4	14.6	12.6	41.2	28	14.4	12.5	39.6	27.5	14.7	12.2
Type II (sweet-curd).												
Iowa:												
E. G. H., Union	41.5	26	13	12	39.5	25	13	11.5	......	......	......	......
Illinois:												
J. B. G., Sterling	38.5	24.5	13.5	11	39	25.5	13.5	11.1	39	25	13.5	11
Total	80	50.5	26.5	23	78.5	50.5	26.5	22.6	......	......	......	......
Average	40	25.2	13.2	11.5	39.2	25.2	13.2	11.3	39	25	13.5	11
Type III (soft).												
Michigan:												
A. H. B., Merrill, I	36	26	11	11.6	36.5	26.5	11.5	11.8	37	26.5	11	11.6
A. H. B., Merrill, II	40	26	11	11	38.5	25.5	11	11	37.5	25.5	11	11
A. H. B., Merrill, III	38	27	13	11.3	39.5	25.5	11	11.4	38.5	26	12.5	11.4
A. H. B., Merrill, IV	43	27	12	12.3	42.5	27.5	12.5	12.3	40.5	25	11	11.8
Total	157	106	47	46.2	157	105	46	46.5	153.5	103	45.5	45.8
Average	39.2	26.5	11.7	11.5	39.2	26.2	11.5	11.6	38.4	25.7	11.4	11.4

In the first test the jury consisted of Messrs. White, Millar, and Kirkpatrick. In the second test, made when the cheese was 5 months old, one of the judges (Kirkpatrick) was unfortunately unable to assist. It is therefore impossible to compare with each other the average scores secured in these two tests, as the judgment of the different members of the jury naturally is not uniform. In comparing, therefore, the course of ripening in the three and five months' tests, it will be necessary to correct the averages given by eliminating the score of the judge who was absent in the second test.

For purposes of study, however, the two tests can be considered independently and the influence of the different temperatures on the character of the cheese determined.

RESULTS OF FIRST JURY TRIAL.

When the cheese had been cured for three months, the sample cheese which had been tested previously at monthly intervals by Mr. Baer, was shipped by refrigerator service to Chicago and submitted to the jury for examination. In the appendix (p. 62) are given the



THREE CHEESE SECTIONS—ILLINOIS CHEESE.

Cheese at top cured at 40°, in middle at 50°, and at bottom at 60°.

detailed data collected at this time. The average of these scores for the different types of cheese and at different temperatures is presented in the table on page 45. Necessarily these data must be discussed on the basis of the different types and not considered together. When this is done the following conclusions appear to be warranted.

Type I (firm, solid, export cheese).—In the four lots of cheese which comprised this group the 50° product was higher in flavor twice, the 40° once, and once the 40° and 50° were alike. In no case, even at this age, when the 60° cheese was at its best (as shown by the serial examinations made by Mr. Baer), did this cheese reach as fine a flavor as at the lower temperatures.

In texture the 40° lot was ahead twice, once the 50° and 60° were alike, and once the 60° was the highest.

As to price, in no case did the 60° equal the value set upon the cheese cured at the lower temperatures, although the difference given by the judges was slight. It must be remembered that the price assigned by the commercial jury was influenced materially by the fact that there is considerable difference in quality, even among the best types of cheese, without a corresponding difference in price. In the majority of cases, when the cheese scored within one or two points of perfect, the price was cut from a quarter to a half cent below the market standard (13 cents), simply because the appearance of the cheese on the surface (mold, etc.) warranted this reduction from a purely commercial point of view. The judges were free to admit that intrinsically the cold-cured cheese was of much better quality than is usually obtained in the market. This cheese was box-cured and received no especial care throughout the experiment; consequently the exterior appearance of the same had been impaired. With proper control this condition could have been entirely obviated, as we have been able to show repeatedly where cheese was cold-cured under our direct supervision.

Type II (sweet-curd cheese).—In this type, in which less acid was developed, little or no difference was observed in the Iowa goods; but in the Illinois cheese the 40° product had a better flavor and texture than the cheese cured at 50° or 60°. Plate IV shows the appearance of the Illinois cheese cured at the three temperatures when 3 months old.

Type III (soft, home-trade cheese).—This type is represented by four different lots from the same factory. All of the lots were highly acid and were of somewhat inferior make. Then, too, the earlier lots were delayed in transit from the factory to the curing station, so that the results of the experiment should not be considered as necessarily typical of the cold-curing process. In this group of four tests the 50° goods were ahead twice on flavor, the 60° once, and once the 40° and 60° were alike. In texture the 50° was highest three times out of four.

GENERAL SUMMARY OF THE FIRST (THREE MONTHS) TEST.

The cheese was examined at this date by the commercial judges, as it was thought that the highest temperature cheese (60°) had reached its maximum condition. It was naturally expected that the 60° product at this time would rank higher in quality than the cold-cured goods. From the above data, it is evident that such a condition did not obtain, as is indicated in the following summary of scores:

Summary of average scores for types I, II, and III, at three months.

	At 40°.	At 50°.	At 60°.
Average scores of ten lots on flavor	41.66	42.28	41.78
Average scores of ten lots on texture	27.01	27.24	26.85
Number of times each lot has highest score on flavor	2	4	1
Number of times each lot tied on score on flavor	3	2	2
Number of times each lot had highest score on texture	3	3	3
Number of times each lot tied on score on texture	0	1	1

From this it appears that the 50° cheese was superior in flavor and texture, not only on the basis of the total scores, but also as to the number of times they ranked highest or equal to the cheese cured at either of the other temperatures. This test was made before the 40° goods were marketable, but even at this time this cheese compared favorably with the 60° product.

RESULTS OF SECOND JURY TRIAL.

The second commercial scoring was made at the end of five months, at which time it was thought that the cold-cured goods could best be judged from a market point of view. The results of this scoring follow:

Type I.—In the four lots tested of this firm-bodied cheese, the 40° was highest in flavor three times and the 60° once. Averaging the total scores shows that the 40° cheese scored 2.8 points higher than the 60°, and even the 50° was 1.6 points above the cheese held at what has been considered ideal curing conditions.

In texture the 40° was highest twice, while in the other cases the scores were equal. Numerically, the average texture of the 40° was nearly a point above the 60°. At this age the 60° goods began to show signs of deterioration, while the cold-cured goods kept much better.

Type II.—In this test one lot of the 60° goods (Iowa) was mislaid in transit, and hence was not tested, but in this case the 40° was 2 points above the 50° in flavor, and 1 point on texture. In the Illinois cheese but little difference was observed.

Type III.—In this softer cheese, twice the 40° scored highest in flavor, the 50° and 60° once each. On texture the 40° scored highest twice, the 50° once, and the 50° and 60° tied once.

GENERAL SUMMARY OF SECOND (FIVE MONTHS) TEST.

In this test the average score, as well as the number of times any lot has scored the highest, shows that the 40° cheese was superior to those at either of the other temperatures, while at this age the 60° cheese showed that it had passed its prime. The summary of these scores is indicated below:

Summary of average scores for types I, II, and III, at five months.

	At 40°.	At 50°.	At 60°.
Average scores of nine lots on flavor	40.65	40.05	39.0
Average scores of nine lots on texture	27.0	26.75	26.4
Number of times each lot had highest score on flavor	6	1	2
Number of times each lot tied on score on flavor	0	1	1
Number of times each lot had highest score on texture	5	2	0
Number of times each lot tied on score on texture	1	3	3

COMPARISON OF THE FIRST AND SECOND JURY TRIALS AS INDICATING THE KEEPING QUALITY OF THE CHEESE.

It is important to compare the scores of the commercial judges made at the first and second jury trials, as in this way it is possible to study the keeping quality of the cheese cured at different temperatures. Unfortunately one of the judges could not be present at the second test. Therefore the judgment of the other two has been used in comparing the data of the two tests. The average scores of flavor and texture of these judges, made at the first and second trials, are given below:

Comparison of average scores made by the same judges at the 3 and 5 months' tests.

Type.	At 40° F.			At 50° F.			At 60° F.		
	Three months.	Five months.	Difference.	Three months.	Five months.	Difference.	Three months.	Five months.	Difference.
Flavor (standard 45).									
I	42.4	42.4	0	43.2	41.2	2	42.5	39.6	2.
II	41.5	40	1.5	41.3	39.2	2.1	41	39	2
III	40.3	39.2	1.1	40.8	39.2	1.6	40.4	38.4	2
Texture (standard 30).									
I	27	28.4	[a] −1.4	27.8	28	-0.2	27.2	27.5	−0.3
II	26.5	25.2	1.3	25.8	25.2	0.6	26	25	1.0
III	26.1	26.5	—0.4	27	26.2	0.8	26	25.7	0.3
Price (standard, 13 cents).									
I	12.4	12.6	- 0.2	12.6	12.5	0.1	12.4	12.2	0.2
II	11.7	11.5	−0.2	11.6	11.3	0.3	11.7	11	0.7
III	11.6	11.5	0.1	11.9	11.6	0.3	11.9	11.4	0.5

[a] Where quality improved with age instead of deteriorating, it is indicated in column of difference by the use of the minus sign.

The above table is instructive in showing the progress of the curing at three and five months periods.

Type I.—With reference to flavor, type I showed its better keeping qualities, inasmuch as it held its own at 40°, while at 50° the cheese had deteriorated 2 points and at 60° 2.9 points. The texture improved at all temperatures as the age increased, but was much more pronounced (over a point) at 40° than at 50° or 60°. This improvement in flavor and texture is also reflected in the enhancement in commercial value. The 40° gained 0.2 cent per pound in three to five months, while the 50° fell off 0.1 cent and the 60° 0.2 cent per pound. Thus in all ways the advantage of cold curing is evident on this firm, solid type of the Wisconsin cheese.

Type II.—In this type, in which less acid was developed than in the typical Cheddar type, the deterioration in flavor was less at 40° than at either 50° or 60°. In texture, however, all scored lower at five months, the data showing a wider difference at 40° than at the other two temperatures. In price, however, the cheese was considered to be worth 0.2 cent per pound more at 40°, while the 60° cheese had depreciated 0.7 cent.

Type III.—In the softer Michigan make, in which more rapid deterioration would be expected, the falling off in flavor was 2 points at 60° as against 1.1 points at 40°. In texture the 40° improved 0.4 point, while the other two depreciated 0.8 and 0.3 point, respectively. In price, all these goods were of less value at five months than at three, but they had depreciated 0.5 cent at 60° and only 0.1 cent at 40°.

Summarizing the above, there can be no question but that the keeping quality of all of these various types of American cheese is improved by curing them at these lower temperatures. This is more evident with the firm, solid Wisconsin type of Cheddar than with the softer, quick-curing goods; but even these can be held with less deterioration at these temperatures than is possible under present curing conditions.

SUMMARY OF EFFECT OF TEMPERATURE ON QUALITY.

As the three different types of cheese represented in these experiments varied so much in character, it will be fairer to state the conclusions with relation to each separately. The scores on these lots of cheese were made separately by our own cheese expert throughout the whole curing period, and also at stated intervals by the commercial judges.

Type I (firm-bodied, typical Cheddar cheese).—At 60° F. flavor developed more rapidly than at lower temperatures, but the maximum score at this temperature, as indicated by Baer, was equaled or exceeded by the maximum score at 50° or 40°. In the scoring made by the commercial jury the 50° averaged 0.6 point higher than the 60°, when cheese was 3 months old. When 5 months old, the 40° was 2.8 points higher than the 60°, and the 50° 1.6 points higher.

In texture the course of development was quite the same, the judges scoring the 50° ahead at 3 months, but at 5 months the 40° averaged nearly a point higher than the 60°.

Type II (*sweet-curd type*).—In this low-acid cheese the course for ripening followed the same rule as in the above type, although this cheese was inferior in quality to the preceding type.

Type III (*soft home-trade type*).—The results on this quick-curing type of cheese were affected by the delay in transit, which permitted of a considerable degree of ripening before the cheese was put in the curing rooms. In this type of cheese the improvement was less marked, but when the enhanced keeping quality is considered, the cold-curing process was found to be advantageous even under these advanced conditions.

C. INFLUENCE OF PARAFFINING ON QUALITY OF CHEESE.

With the use of lower temperatures for curing, a higher degree of saturation of the atmosphere is always found, which greatly promotes the development of mold, and this growth injures the salability, though not the quality, of the cheese, and hence many attempts have been made to overcome the difficulty. The most efficient method yet proposed is to coat the surface of the cheese with an impervious layer, which, by excluding oxygen, prevents development of molds. For this purpose the cheeses are immersed in a bath of melted paraffin, which, upon cooling, adheres closely to the surface. While this effectually accomplishes the desired end, it is a question of importance whether the quality of the cheese so treated is affected prejudicially or not. It is possible to conceive that the retention of all volatile decomposition products within the cheese might injure the flavor of the product.

In these cheese-curing experiments it was thought advisable to institute a series of trials to determine what influence paraffining had on the quality, as shown by the flavor and texture scores. For this purpose the cheese which was used in the experiments on shrinkage (La Crosse lot) was scored by Mr. Baer, and was also submitted to the experts for scoring at the regular periods. These scores are to be found in the appendix (pp. 58 and 64), but, in order to permit of a more ready comparison, a summary of the flavor and texture scores of the paraffined and the normal cheese is presented in the following table:

Comparative scores of paraffined and unparaffined cheese (daisies and 10-pound prints).

20-POUND DAISIES.

Curing temperature.	Age by months.	Flavor.				Texture.			
		Paraffined.	Unparaffined.	Difference.		Paraffined.	Unparaffined.	Difference.	
				Paraffined.	Unparaffined.			Paraffined.	Unparaffined.
40° F	1	....	30	....	....	....	23	....	....
	2	30	34	....	4	22	26	....	4
	3	43.5	40	3.5	....	29.5	29	0.5	....
	[a]3	43.3	43.3	0	0	28.6	28.6	0	0
	5	40	40	0	0	29	28	1	....
	[a]5	41.5	41	0.5	....	27	27.5	....	0.5
50° F	1	....	30	....	....	....	24	....	....
	2	33	35	....	2	23	27	....	4
	3	41	40	1	....	28	29	....	1
	[a]3	43	43	0	0	28.6	28.3	0.3	....
	5	39	38	1	....	28	27	1	....
	[a]5	40.5	40	0.5	....	26.5	26.5	0	0
60° F	1	30	28	2	....	22	26	....	4
	2	33	30	3	....	26	27	....	1
	3	38	38	0	0	27	29	....	2
	[a]3	41.3	42	....	0.7	27.6	27.3	0.3	....
	5	38	35	3	....	28	25	3	....
	[a]5	39.5	35	4.5	....	28	25	3	....

10-POUND PRINTS.

Curing temperature.	Age by months.	Flavor.				Texture.			
		Paraffined.	Unparaffined.	Difference.		Paraffined.	Unparaffined.	Difference.	
				Paraffined.	Unparaffined.			Paraffined.	Unparaffined.
40° F	1	38	38	0	0	22	22	0	0
	2	38	38	0	0	25	25	0	0
	[a]3	43.3	43	0.3	....	28.3	27.6	0.7	....
50° F	1	38	38	0	0	24	24	0	0
	2	41	41	0	0	26	26	0	0
	[a]3	43.3	43.3	0	0	28.6	28	0.6	....
60° F	1	40	40	0	0	25	25	0	0
	2	43	42	1	....	28	27	1	....
	3	45	44.5	0.5	....	29.5	29.5	0	0
	[a]3	43.3	42.6	0.7	....	28.6	28.6	0	0

[a] This indicates that the score made at this time was by the commercial experts. Scores of same date not bearing reference mark are by Mr. Baer.

From these data it is evident that the difference between the same lot of cheese when paraffined or unparaffined is very slight. If the course of curing is considered, as is shown by the scores of Mr. Baer, which were taken when the cheese was 1, 2, 3, and 5 months old, it is apparent that the application of paraffin has not injured either the flavor or the texture of the cheese. By reference to the column headed "Difference" in the above table, it will be further noted that in the daisies the unparaffined cheese was, with one exception (60°), better at the beginning; but throughout the remainder of the curing and to the end of the experiment the paraffined improved much more rapidly, and without exception was as good as or better than the unparaffined.

With the prints the difference in scores was practically negligible.

This same cheese was scored by the commercial experts when it was three and five months old, and it should be noted that the opinions of these experts coincided quite closely with those of Mr. Baer.

It would be unsafe from these limited experiments to draw any general conclusions, but so far as they go these trials show that no injurious effect was observed on either the flavor or the texture of the paraffined cheese.

GENERAL SUMMARY.

The purpose of the experiments detailed above was to test the value of low temperatures for the curing of cheese made under widely different but commercial conditions. To accomplish this purpose, it was deemed advisable to purchase the product from a wide range of territory. This condition rendered it impossible to install the cheese in the curing rooms immediately after it was taken from the press, and hence the full effect of the process is not so evident as would have been the case if the cheese had not had any preliminary curing.

Naturally a comparison of the cold-curing process would be made with the conditions most frequently found in factories, but in these studies the low temperature cured product has been compared with cheese ripened at about 60° F.—a temperature which has hitherto been considered as the best for the ripening of Cheddar cheese.

EFFECT ON SHRINKAGE.

When cheese is cold-cured, the losses due to shrinkage in weight are greatly reduced over what occurs under ordinary factory conditions.

(1) *Influence of temperature.*—Cheese cured at 40° F. decreased in weight in ninety days from 1 to 1.4 per cent, while that cured at 50° and 60° F. lost fully three times as much. This saving would be still further increased if comparison were made between the results of cold curing and existing factory conditions. Under prevailing factory practice cheese is sold at a much earlier date than is advisable with cold-cured goods, but the loss under present conditions, for even as brief a curing period as twenty days, is fully four times as great as has occurred in these experiments in a ninety-day period (the minimum curing period recommended) under cold-curing conditions (40° F.). This saving in a factory making 500 pounds of cheese daily would average not less than 15 pounds of cheese per day for the entire season, or considerably more than this if only summer-made cheese was cold cured.

(2) *Influence of type of cheese.*—In these experiments different types of cheese were used, ranging from the firm, typical Cheddar to the soft, moist, quick-curing cheese made for the home trade. The losses with the firmer type were considerably reduced in comparison with the other, but the conditions to which the softer types of cheese were subjected were not as favorable (because of initial delays), and hence the losses with these types can not be relied upon with such definiteness. As this cheese was exceedingly moist, the total losses from the press were undoubtedly greater than here reported.

(3) *Influence of size of cheese.*—The size of package exerts a marked effect on the rate of loss. At ordinary temperatures, the smaller the cheese the more rapidly it dries out. This difference in loss diminishes as the temperature is lowered, and in our experiments at 40° F. was practically independent of the size. This condition, however, was undoubtedly attributable to the relative humidity of the curing room, which at 40° F. was 100 per cent.

(4) *Influence of paraffin.*—By coating the cheese with melted paraffin the losses at 60° were reduced more than one-half at 50°; the saving was somewhat less, and at 40° the losses observed on the paraffined cheese of both sizes used were slightly in excess of those noted on the uncoated cheese.

(5) As some loss occurs even in a saturated atmosphere, where evaporation is presumed not to take place, it implies that the shrinkage in weight of cheese under these conditions is not wholly due to desiccation, but is possibly affected by the production of volatile products that are formed by processes inherent in the curing of cheese.

EFFECT ON QUALITY.

(6) The three types of cheese above referred to can scarcely be compared closely with each other, as they were so different in their make-up and subjected to somewhat different conditions during transit. By far the most satisfactory portion of the experiment is that which relates to type I, in which the best quality of cheese was represented. With these firm, typical Cheddars the influence of temperature on curing could best be studied. This cheese was also placed in storage nearer the press than any of the other types, and hence the test as to the effect of the curing temperature was more satisfactory. In this type the 60° cheese was of excellent quality and naturally developed faster than the cold-cured goods, but in time it was surpassed by the cheese at the lower temperatures (50° and 40°), and, when the keeping quality of the latter was taken into consideration, it was found to be superior in every way to that cured at 60°. Even when the condition of the milk was not entirely perfect, the quality of the cold-cured cheese was better, although the original taint was not removed.

With the sweet-curd (type II) and the soft home-trade cheese (type

III) the effect of the disturbing influences previously noted rendered it impossible to obtain as satisfactory results, but, even under these adverse conditions, the 40° and 50° cheese generally ranked better than the 60°, and, when keeping quality was taken into consideration, was materially better.

This same cheese was also scored independently by commercial experts when three and five months old. The results obtained conform very closely to those mentioned above, and indicate the superiority of the cold-cured product (either at 50° or 40°) in comparison with the cheese cured at 60°. This improvement in quality reflects itself also in the commercial values which were placed upon the cheese cured at different temperatures, both by our own expert and also by the commercial judges.

In this low-temperature-cured cheese the flavor was remarkably mild but clean, and was free from all trace of bitterness or other taint. The texture was fine and silky and the body close.

(7) *Keeping quality.*—The keeping quality of the cold-cured cheese far excels that of the cheese ripened at higher temperatures. The better types of cheese cured at 40° F. are at present writing (eight months) still in their prime, while the 60° cheese has long since greatly deteriorated.

(8) *Effect of paraffin on quality.*—Portions of two lots of cheese were paraffined as they came from the press, but were otherwise handled the same as the unparaffined cheese. The results obtained showed that paraffining did not prejudicially affect their quality at any temperature. As paraffining greatly reduced the shrinkage, the beneficial effect of the system is obvious. The rapid introduction of the method in commercial practice further attests its value.

(9) The production of a thoroughly broken-down Cheddar cheese of mild, delicate flavor and perfect texture meets a demand which is impossible to satisfy with cheese cured at high temperatures. Without any question, if the general market can be supplied with this mild, well-ripened cheese, consumption will be greatly stimulated, not only by increasing the amount used by present consumers, but by largely extending the use of this valuable and nutritious article of food.

(10) The improvement in quality of cold-cured cheese, the enhanced keeping quality, and the material saving in shrinkage due to lessened evaporation are sufficient to warrant a considerable expenditure on the part of cheese producers in installing cold-curing stations.

The principle of increasing cost of equipment to lessen cost of production or augment gross earnings is recognized as a sound financial method by all large enterprises, and, while the expense involved is considerably more than is incurred under existing conditions, yet the advantages enumerated more than compensate for such expense where carried out under proper conditions.

(11) This system is particularly applicable where the product of a number of factories can be handled at one point, and such consolidated curing stations must be established before the cold-curing process can be economically introduced. Such stations are now successfully used in a number of localities. The greatest advantage will undoubtedly accrue from the use of this system of curing with summer-made cheese, but the process is equally applicable to cheese made at any season of the year.

APPENDIX.

In the following appendix are given the original data collected in the series of examinations made by Mr. Baer and the commercial experts. From these data are compiled the summaries which are presented in the text of the foregoing bulletin.

Results of examinations by Mr. Baer during progress of curing cheese in type I (firm, export Cheddar type).

LOT 1.—THOS. JOHNSTON, BOAZ, RICHLAND COUNTY, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, clean but low; body, close; texture, curdy but meaty; curd particles well cemented; color, straight, even; cheese, well made.

Curing temperature.	Age of cheese when examined.	Numerical scores.			Descriptive scores.			Commercial value (standard, 13 cents).
		Flavor (standard, 45).	Texture (standard, 30).	Color (standard, 15).	Flavor.	Texture and body.	Color.	
	Months.							
40° F	1	35	24	15	Flat, low	Curdy	O. K	....
	2	37	27	14	Flat	Curdy	Streaked	9
	3	40	29	14	Clean, low	Smooth	Wavy	10.5
	5	42	29	15	Clean	Stiff	O. K	12.5
	8	45	29	15	Clean, high	Stiff, close	O. K	13
50° F	1	38	22	15	Low	Stiff	O. K	....
	2	40	24	15	Low	Stiff	O. K	10.5
	3	42	28	15	Low	Waxy	O. K	12.5
	5	38	29	15	Tainted	Loose	O. K	11.5
60° F	1	38	24	15	Flat	Stiff	O. K	....
	2	43	25	15	Flat	Stiff	O. K	11.5
	3	44	29.5	15	Clean	Silky	O. K	13
	5	36	27	15	Off	Loose	O. K	10.5

LOT 2.—H. J. NOYES, MUSCODA, GRANT COUNTY, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, clean; body, close, meaty; texture, smooth; color, bright, straight, natural amber; curd particles firmly cemented; not so dry and firm as lot 1.

	Months.							
40° F	1	35	20	15	Flat, low	Curdy	O. K	....
	2	37	21	15	Flat	Curdy	O. K	10
	3	41	26.5	15	Clean	Smooth	O. K	11.75
	5	45	30	15	Clean, high	Silky	O. K	13.25
	8	45	30	15	Clean, high	Silky	O. K	13.25
50° F	1	35	21	15	Low	Curdy	Dull	....
	2	35	22	15	Low	Curdy	Dull	10
	3	42	27	14	Clean	Mealy	Dull	12
	5	44	30	15	Clean, high	Silky	O. K	13
60° F	1	35	20	14	Low	Curdy	Dull	....
	2	38	25	15	Low	Curdy	Dull	....
	3	44	29.5	15	Clean, high	Smooth	O K	13
	5	44	29	15	Clean, high	Silky	O. K	13

Results of examinations by Mr. Baer during progress of curing cheese in type I (firm, export Cheddar type)—Continued.

LOT 3.—P. H. KASPER, NICHOLSON, WAUPACA COUNTY, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, high and clean; body, close and meaty; texture, smooth and silky; color, a splendid light amber, clear and straight; boxed and packed in excellent shape; cheese arrived in splendid condition; neatly bandaged and perfectly made; the finest cheese placed in storage.

Curing temperature.	Age of cheese when examined.	Numerical scores.			Descriptive scores.			Commercial value (standard, 13 cents).
		Flavor (standard, 45).	Texture (standard, 30).	Color (standard, 15).	Flavor.	Texture and body.	Color.	
	Months.							
40° F	2	40	26	15	Clean	Smooth	O. K	12
	3	45	30	15	Clean	Silky	O. K	13
	5	45	30	15	Clean	Silky	O. K	13.25
	8	45	29	15	Clean, high.	Close, meaty.	O. K	13
50° F	1	....	....	....	Clean	Curdy	O. K	....
	2	43	28	15	Clean	Smooth	O. K	12.5
	3	45	30	15	Clean	Silky	O. K	13
	5	44	30	15	Clean	Silky	O. K	13
60° F	1	42	27	15	Clean	Smooth	O. K	12
	2	45	30	15	Clean	Smooth	O. K	13
	3	43	28	15	Clean	Loose	O. K	12
	5	43	29	14	Clean	Silky	O. K	12.75

LOT 4.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, not clean; body, close meaty; color, O. K.; cheese well made; the only fault found with this goods was the objectionable flavor, resembling that resulting from frozen feed.

20-pound daisies.

	Months.							
40° F	1	30	23	12	Tainted	Curdy	O. K	....
	2	34	26	12	Tainted	Waxy	O. K	9
	3	40	29	14	Tainted	Waxy	Wavy	12
	5	40	28	13	Low	Close	Wavy	11.75
	8	40	28	14	Off, flat	Fair	Wavy	11.75
50° F	1	30	24	12	Tainted	Curdy	O. K	....
	2	35	27	12	Tainted	Stiff	O. K	9
	3	40	29	14	Tainted	Waxy	O. K	12
	5	38	27	13	Tainted	Waxy	Mottled	10.5
60° F	1	28	26	13	Tainted	Curdy	O. K	....
	2	30	27	14	Tainted	Waxy	O. K	8
	3	38	29	14	Tainted	Smooth	O. K	11.5
	5	35	25	10	Tainted	Gassy	Faded	9.5

Results of examinations by Mr. Baer during progress of curing cheese in type I (firm, export Cheddar type)—Continued.

LOT 5.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, clean but low; texture, good; color, O. K.; cheese well made and of fine quality.

10-pound prints.

Curing temperature.	Age of cheese when examined.	Numerical scores.			Descriptive scores.			Commercial value (standard, 13 cents).
		Flavor (standard, 45).	Texture (standard, 30).	Color (standard, 15).	Flavor.	Texture and body.	Color.	
	Months.							
40° F.	1	38	22	15	Clean	Curdy	O. K	....
	2	38	25	15	Clean	Curdy	O. K	10
	3	43	27	15	Clean	Waxy	O. K	12
	8	42	27	15	Not clean	Mealy	O. K	12
50° F.	1	38	24	15	Clean	Curdy	O. K	....
	2	41	26	15	Clean	Curdy	O. K	10.5
	3	43	27	15	Clean	Smooth	O. K	12.75
60° F.	1	40	25	15	Clean	Curdy	O. K	....
	2	42	27	15	Clean	Smooth	O. K	12.75
	3	44.5	29.5	15	Clean, high.	Smooth	O. K	13

LOT 6.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, not clean; body, close, meaty; color, O. K.; cheese well made, put up in neat, attractive form.

20-pound paraffined daisies.

	Months.							
40° F.	1	....	....	....	Low	Curdy	O. K	....
	2	30	22	15	Low	Curdy	O. K	9
	3	43.5	29.5	15	Clean	Waxy	O. K	13
	5	40	29	14	Low	Waxy	O. K	12
	8	40	29	12	Off	Waxy, open	Mottled	11.75
50° F.	1	....	....	....	Low	Curdy	O. K	....
	2	33	23	15	Low	Curdy	O. K	10
	3	41	28	15	Tainted	Smooth	O. K	12.25
	5	39	28	14	Low	Waxy	O. K	12
60° F.	1	30	22	15	Low	Curdy	O. K	9
	2	33	26	15	Tainted	Salvy	O. K	10.5
	3	38	27	15	Tainted	Salvy	O. K	11.5
	5	38	28	13	Tainted	Waxy	O. K	11.5

LOT 7.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, WIS.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, clean but low; body, close, meaty; color, O. K.; cheese of very fine quality.

10-pound paraffined prints.

	Months.							
40° F.	1	38	22	15	Clean	Curdy	O. K	....
	2	38	25	15	Clean	Curdy	O. K	10
	8	42	28	15	Not clean, high.	Mealy	O. K	12.25
50° F.	1	38	24	15	Clean	Mealy	O. K	....
	2	41	26	15	Clean	Mealy	O. K	10.5
60° F.	1	40	25	15	Clean	Mealy	O. K	....
	2	43	28	15	Clean	Stiff	O. K	12.75

Results of examinations by Mr. Baer during progress of curing cheese in type II (sweet-curd type).

LOT 1.—E. G. HODGES, UNION, IOWA.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, clean but low; sweet, insipid taste; body, slightly loose; texture crumbly; color, O. K.; very small Swiss holes.

Curing temperature.	Age of cheese when examined.	Numerical scores.			Descriptive scores.			Commercial value (standard 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture and body.	Color.	
	Months.							
40° F.	1				Flat	Curdy	Wavy	
	2	40	24	14	Flat	Waxy	Wavy	10.5
	3	43	29	14	Low	Clean	Wavy	12.5
	5	41	27	14	Flat	Loose	Wavy	11.5
50° F.	1				Flat	Curdy	Wavy	
	2	38	25	13	Flat	Waxy	Wavy	10.5
	3	43	27	13	Low	Open	Wavy	12.25
	5	40	27	14	Low	Loose	Wavy	11
60° F.	1	35	22	12	Low	Curdy	Wavy	9.5
	2	36	24	12	Flat	Waxy	Wavy	10
	3	40	27	12	Low	Open	Wavy	11.5

LOT 2.—J. B. GILBERT & CO., STERLING, ILL.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, clean but low; body, slightly loose; small Swiss holes; made soft and moist.

Curing temperature.	Age of cheese when examined.	Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture and body.	Color.	Commercial value (standard 13 cents).
	Months.							
40° F	1				Low	Pasty	O. K	
	2	35	23	15	Low	Pasty	O. K	9.5
	3	38	25	15	Low	Loose	O. K	10
	5	37	25	14	Flat	Pasty	O. K	10.5
50° F	1				Low	Pasty	O. K	
	2	38	25	15	Low	Pasty	O. K	10
	3	38	25	15	Low	Pasty	O. K	10
	5	36	25	14	Low	Pasty	O. K	10.5
60° F	1	35	22	15	Low	Pasty	O. K	9.5
	2	37	22	15	Low	Pasty	O. K	9.5
	3	40	20	15	Low	Open	O. K	10
	5	35	25	14	Low	Pasty	O. K	10.25

Results of examinations by Mr. Baer during progress of curing cheese in type III (soft, home-trade type).

LOT 1.—A. H. BARBER & CO., MERRILL, MICH.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, fair; body, loose, open; slightly huffed; color, O. K.; slightly open under the bandage; too highly acid; packages poor.

Curing temperature.	Age of cheese when examined.	Numerical scores.			Descriptive scores.			Commercial value (standard 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture and body.	Color.	
	Months.							
40° F....	1	....	....	....	....	Mealy, acid	O. K........	....
	2	30	21	14	....	....	....	9.5
	3	35	24	14	Acidy	Sticky	O. K........	11
	5	35	25	10	Sour........	Mealy	Cut.........	9
50° F....	1	....	....	....	Acidy	Mealy	O. K........	....
	2	30	23	14	Acidy	Mealy	O. K........	9.5
	3	35	26	14	Acidy	Pasty......	O. K........	11
	5	32	23	10	Sour........	Mealy	Cut.........	8
60° F....	1	31	22	12	Acidy	Mealy	O. K........	8
	2	35	25	12	Acidy	Mealy	O. K........	10
	3	38	22	14	Acidy	Pasty......	O. K........	11
	5	35	25	10	Sour........	Mealy	Cut.........	9

LOT 2.—A. H. BARBER & CO., MERRILL, MICH.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, fair; body, loose, open; slightly huffed; color, O. K.; packages, poor, cheese started to mold.

	Months.							
40° F	3	40	27	12	Acidy	Pasty......	Cut.........	11
	5	38	24	11	Acidy	Tallowy ...	Cut.........	11
50° F	3	41	28	12	Acidy	Salvy......	Cut.........	11.5
	5	37	25	11	Acidy	Tallowy ...	Cut.........	10.5
60° F	3	41	28	12	Acidy	Salvy......	Cut.........	11.5
	5	35	27	11	Acidy	Tallowy ...	Cut.........	10.5

LOT 3.—A. H. BARBER & CO., MERRILL, MICH.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, low but clean; body, slightly loose; texture curdy and short; cheese was soft; showed excess of moisture on the end surfaces; too highly acid; boxes badly broken and cheese moldy.

	Months.							
40° F.....	1	....	....	....	Acidy	Mealy	O. K	....
	2	33	22	14	Acidy	Mealy	O. K	9
	3	38	25	14	Acidy	Tallowy ...	Wavy.......	10
	5	38	27	12	Acidy	Loose......	Cut.........	11
50° F.....	1	....	....	....	Acidy	Mealy	O. K	....
	2	38	23	14	Acidy	Mealy	O. K	10
	3	40	25	14	Low	Tallowy ...	O. K	11
	5	37	26	10	Acidy	Loose......	Cut.........	10.5
60° F.....	1	....	....	....	Not clean...	Mealy	O. K	....
	2	38	23	14	Not clean...	Mealy	O. K	10
	3	40	28	14	Low	Salvy	O. K	11.5
	5	35	25	10	Acidy	Loose......	Cut.........	10

Results of examinations by Mr. Baer during progress of curing cheese in type III (soft, home-trade type)—Continued.

LOT 4.—A. H. BARBER & CO., MERRILL, MICH.

NOTE.—The following observations were made by Mr. Baer upon receipt of the cheese at cold-curing station: Flavor, low but clean; body, loose; texture, short; cheese was soft; showed excess of moisture on rinds; boxes badly broken; cheese quite moldy.

Curing temperature.	Age of cheese when examined.	Numerical scores.			Descriptive scores.			Commercial value (standard 13 cents).
		Flavor (standard 45).	Texture (standard 15).	Color (standard 15).	Flavor.	Texture and body.	Color.	
	Months.							
40° F	1	....	....	....	Acidy	Short	Wavy	....
	2	35	22	14	Acidy	Curdy	Wavy	9.5
	3	43	29	14	Low	Waxy	Wavy	12.75
	5	40	27	12	Low	Loose	Cut	10.75
50° F	1	....	....	....	Acidy	Short	Wavy	....
	2	38	22	13	Acidy	Short	Wavy	11
	3	43	26	13	Flat	Short	Wavy	12
	5	42	28	12	Clean	Loose	Cut	11.75
60° F	1	35	24	13	Acidy	Short	Wavy	10
	2	38	22	13	Acidy	Short	Wavy	11.5
	3	42	26	12	Flat	Short	Wavy	12
	5	38	25	12	Sour	Loose	Cut	10.5

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS.

Type I (firm export Cheddar type).

LOT 1.—THOS. JOHNSTON, BOAZ, RICHLAND COUNTY, WIS.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	43	28.5	13.5	Clean	Waxy	Specks	12
	Kirkpatrick	41	27	12	Low	Salvy	Mottled.	12.75
	Millar	40	22	10	Clean	Pasty	Mottled.	12.25
	Average	41.3	25.8	11.8	....	....	....	12.33
50° F	White	45	29	15	Perfect	Silky	O. K	12.5
	Kirkpatrick	44	28	14	Clean	Waxy	O. K	12.5
	Millar	41	26	14	Clean	Waxy	O. K	12.75
	Average	43.3	27.6	14.3	....	....	....	12.58
60° F	White	43	29	14	Clean	Smooth	O. K	12.25
	Kirkpatrick	42	29	14	Tainted	Silky	O. K	12
	Millar	42	28	14	Clean	Smooth	O. K	13
	Average	42.3	28.6	14	....	....	....	12.41

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type I (firm export Cheddar type)—Continued.

LOT 1.—THOS. JOHNSTON, BOAZ, RICHLAND COUNTY, WIS.

Second jury trial (cheese 5 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F.	White	44	29	15	Clean	Waxy	O. K	12.75
	Millar	43	28	15	Flat	Loose	O. K	12.75
	Average	43.5	28.5	15				12.75
50° F.	White	40	29	15	Bitter	Smooth	O. K	12.5
	Millar	40	28	15	Bitter	Loose	O. K	12.5
	Average	40	28.5	15				12.5
60° F.	White	39	29	15	Off	Smooth	O. K	12.5
	Millar	38	28	15	Off	Smooth	O. K	12.25
	Average	38.5	28.5	15				12.375

LOT 2.—P. H. KASPER, NICHOLSON, WAUPACA COUNTY, WIS.

First jury trial (cheese 3 months old).

40° F	White	44	29	14.5	Clean	Waxy	O. K	12.75
	Kirkpatrick	45	29	15	Clean	Silky	O. K	12.75
	Millar	43	28	15	Clean	Waxy	O. K	12.75
	Average	44	28.6	14.8				12.75
50° F	White	44	29.5	14.5	Clean	Silky	O. K	12.75
	Kirkpatrick	45	28.5	14.5	Clean	Waxy	O. K	12.5
	Millar	43	27	15	Clean	Loose	O. K	12.75
	Average	44	28.3	14.6				12.6
60° F	White	44	27	14.5	Clean	Loose	O. K	12.5
	Kirkpatrick	43	27	14	Flat	Pasty	O. K	12
	Millar	42	25	14	Flat	Salvy	O. K	12.25
	Average	43	26.3	14.16				12.25

LOT 2.—P. H. KASPER, NICHOLSON, WAUPACA COUNTY, WIS.

Second jury trial (cheese 5 months old).

40° F.	White	44	29	15	Clean	Smooth	O. K	13
	Millar	38	27	15	Flat	Loose	O. K	12.12
	Average	41	28	15				12.56
50° F.	White	43	29	15	Bitter	Smooth	O. K	13
	Millar	40	28	15	Clean	Smooth	O. K	12.25
	Average	41.5	28.5	15				12.62
60° F.	White	42	29	15	Sharp	Smooth	O. K	13
	Millar	42	28	15	Clean	Smooth	O. K	12.5
	Average	42	28.5	15				12.75

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type I (firm export Cheddar type)—Continued.

LOT 3.—H. J. NOYES, MUSCODA, GRANT COUNTY, WIS.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	42	28	15	Flat	Pasty	O. K	12
	Kirkpatrick	44	27	15	Clean	Salvy	O. K	12.25
	Millar	41	24	15	Flat	Salvy	O. K	12.25
	Average	42.3	26.3	15				12.16
50° F	White	44.5	29	15	Perfect	Silky	O. K	12.75
	Kirkpatrick	45	28.5	15	Clean	Waxy	O. K	12.5
	Millar	43	26	15	Clean	Waxy	O. K	12.5
	Average	44.1	27.8	15				12.58
60° F	White	43	28.5	15	Clean	Silky	O. K	12.5
	Kirkpatrick	45	29	15	Clean	Silky	O. K	12.5
	Millar	43	26	15	Clean	Silky	O. K	12.5
	Average	43.6	27.8	15				12.5

LOT 8.—H. J. NOYES, MUSCODA, GRANT COUNTY, WIS.

Second jury trial (cheese 5 months old).

Curing temperature.	Judges.	Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	Price (standard, 13 cents).
40° F	White	44	29	15	Clean	Smooth	O. K	13
	Millar	44	30	15	Clean	Waxy	O. K	13
	Average	44	29.5	15				13
50° F	White	44	28	15	Clean	Smooth	O. K	13
	Millar	43	29	15	Clean	Waxy	O. K	12.75
	Average	43.5	28.5	15				12.87
60° F	White	44	29	15	Clean	Waxy	O. K	13
	Millar	42	27	15	Clean	Loose	O. K	12.5
	Average	43	28	15				12.75

LOT 4.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	Price (standard, 13 cents).
40° F	White	44	29	14	Clean	Waxy	O. K	12.75
	Kirkpatrick	44	29	15	Clean	Salvy	O. K	12.75
	Millar	42	28	14	Tainted	Waxy	O. K	12.5
	Average	43.3	28.6	14.3				12.6
50° F	White	44	29	14	Clean	Waxy	O. K	12.75
	Kirkpatrick	44	29	15	Clean	Waxy	O. K	12.75
	Millar	41	27	14	Tainted	Salvy	O. K	12.5
	Average	43	28.3	14.3				12.6
60° F	White	43	28	14	Flat	Smooth	O. K	12.5
	Kirkpatrick	43	28	15	High	Silky	O. K	12.25
	Millar	40	26	14	Tainted	Salvy	O. K	12
	Average	42	27.3	14.3				12.25

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type I (firm export Cheddar type)—Continued.

LOT 4.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

Daisies. Second jury trial (cheese 5 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	40	28	13	Flat	Pasty	Wavy	12
	Millar	42	27	14	Flat	Loose	O. K.	12.25
	Average	41	27.5	13.5				12.12
50° F	White	40	28	12	Flat	Salvy	Wavy	11.75
	Millar	40	25	13	Tainted	Salvy	Faded	12
	Average	40	26.5	12.5				11.87
60° F	White	35	25	13	Off	Loose	Faded	11
	Millar	35	25	13	Tainted	Salvy	Faded	11
	Average	35	25	13				11

LOT 5.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

First jury trial (cheese 3½ months old).

40° F	White	44	28	14	Clean	Waxy	O. K	12.5
	Kirkpatrick	43	28	15	Clean	Waxy	O. K	12.5
	Millar	42	27	13.5	Clean	Waxy	Wavy	12.25
	Average	43	27.6	14.1				12.41
50° F	White	43	28	14	Flat	Waxy	O. K	12.5
	Kirkpatrick	44	28	15	Clean	Waxy	O. K	12.5
	Millar	43	28	14	Clean, low	Smooth	O. K	12.5
	Average	43.3	28	14.3				12.5
60° F	White	43	28	14	Flat	Smooth	O. K	12.5
	Kirkpatrick	43	29	15	Clean	Waxy	O. K	12.5
	Millar	42	28	14	Clean	Smooth	O. K	12.5
	Average	42.6	28.6	14.3				12.5

LOT 6.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

First jury trial (cheese 3 months old).

40° F	White	44	29	14	Clean	Waxy	O. K.	12.75
	Kirkpatrick	44	29	15	Clean	Waxy	O. K.	12.75
	Millar	42	28	14.5	Tainted	Waxy	O. K.	12.5
	Average	43.3	28.6	14.53				12.6
50° F	White	44	29	14	Clean	Smooth	O. K.	12.75
	Kirkpatrick	44	29	15	Clean	Waxy	O. K.	12.75
	Millar	41	28	14.5	Tainted	Salvy	O. K.	12.5
	Average	43	28.6	14.5				12.6
60° F	White	43	28	14	Flat	Smooth	O. K.	12.5
	Kirkpatrick	41	28	15	Tainted	Pasty	O. K.	12
	Millar	40	27	14	Tainted	Salvy	O. K.	12.25
	Average	41.3	27.6	14.3				12.25

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type I (firm export Cheddar type)—Continued.

LOT 6.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

Second jury trial (cheese 5 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	43	26	14	Flat	Smooth.	O. K	12.5
	Millar	40	28	13	Low	Salvy	Wavy	12
	Average	41.5	27	13.5				12.25
50° F	White	42	26	12	Flat	Waxy	Specks	12
	Millar	39	27	13	Low	Salvy	Wavy	11.75
	Average	40.5	26.5	12.5				11.87
60° F	White	41	25	10	Flat	Smooth.	Wavy	11.75
	Millar	38	26	13	Low	Loose	Wavy	11.5
	Average	39.5	25.5	11.5				11.62

LOT 7.—LA CROSSE CHEESE AND BUTTER CO., LA CROSSE, LA CROSSE COUNTY, WIS.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	Price (standard, 13 cents).
40° F.....	White	44	29	14	Clean	Waxy	O. K	12.75
	Kirkpatrick	43	28	15	Clean	Waxy	O. K	12.5
	Millar	43	28	14	Clean	Smooth.	O. K	12.75
	Average	43.3	28.3	14.3				12.6
50° F.....	White	43	29	14	Flat	Smooth.	O. K	12.75
	Kirkpatrick	44	28	15	Clean	Waxy	O. K	12.75
	Millar	43	29	14	Clean	Waxy	O. K	12.75
	Average	43.3	28.6	14.3				12.75
60° F.....	White	44	29	14	Clean	Waxy	O. K	12.75
	Kirkpatrick	43	29	15	Clean	Waxy	O. K	12.5
	Millar	43	28	14	Clean	Smooth.	O. K	12.75
	Average	43.3	28.6	14.3				12.6

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type II (sweet-curd type).

LOT 1.—E. G. HODGES, UNION, IOWA.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	43	28	13	Flat	Stiff	Wavy	12.25
	Kirkpatrick	43	27	14	Clean	Waxy	O. K.	12
	Millar	42	28	13	Clean	Waxy	O. K.	12.5
	Average	42.6	27.6	13.6				12.25
50° F	White	43	26	13	Flat	Waxy	Wavy	12
	Kirkpatrick	43	27	13	Clean	Waxy	Wavy	12
	Millar	42	27	13	Clean	Waxy	Wavy	12.5
	Average	42.6	26.6	13				12.16
60° F	White	43	28	13	Flat	Stiff	Wavy	12.25
	Kirkpatrick	43	28	13.5	Clean	Waxy	Wavy	12.5
	Millar	42	28	13	Clean	Waxy	Wavy	12.5
	Average	42.6	28	13.16				12.4

LOT 1.—E. G. HODGES, UNION, IOWA.

Second jury trial (cheese 5 months old).

Curing temperature.	Judges.	Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	Price (standard, 13 cents).
40° F	White	43	25	12	Low	Mealy	Wavy	12
	Millar	40	27	14	Low	Salvy	Dull	12
	Average	41.5	26	13				12
50° F	White	41	25	12	Off	Loose	Wavy	11.5
	Millar	38	25	14	Low	Weak	Dull	11.5
	Average	39.5	25	13				11.5

LOT 2.—J. B. GILBERT & CO., STERLING, ILL.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	Price (standard, 13 cents).
40° F	White	39	25	14	Low	Pasty	O. K.	11
	Kirkpatrick	42	27	15	Low	Loose	O. K.	11.5
	Millar	41	25	14	Low	Pasty	O. K.	11
	Average	40.6	25.6	14.3				11.16
50° F	White	40	25	14	Low	Pasty	O. K.	11
	Kirkpatrick	40	25	14	Low	Salvy	O. K.	11.25
	Millar	40	25	14	Low	Pasty	O. K.	11
	Average	40	25	14				11.08
60° F	White	40	25	14	Flat	Pasty	O. K.	11
	Kirkpatrick	41	26	14	Low	Pasty	O. K.	11.25
	Millar	39	23	14	Low	Pasty	O. K.	11
	Average	40	24.6	14				11.08

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type II (*sweet-curd type*)—Continued.

LOT 2.—J. B. GILBERT & CO., STERLING, ILL.

Second jury trial (*cheese 5 months old*).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard, 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	39	24	13	Low	Salvy	Wavy	11
	Millar	38	25	14	Low	Salvy	O. K	11
	Average	38.5	24.5	13.5				11
50° F	White	39	25	13	Low	Pasty	Wavy	11.25
	Millar	39	26	14	Low	Loose	O. K	11
	Average	39	25.5	13.5				11.12
60° F	White	38	24	13	Bitter	Salvy	Wavy	11
	Millar	40	26	14	Low	Loose	O. K	11
	Average	39	25	13.5				11

Type III (*soft home-trade type*).

LOT 1.—A. H. BARBER & CO., MERRILL, MICH.

First jury trial (*cheese 3 months old*).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard 13 cents).
		Flavor (standard 40).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	38	25	13	Tainted	Salvy	O. K.	11.75
	Kirkpatrick	41	28	13	Acidy	Pasty	O. K.	12
	Millar	40	25	13	Tainted	Salvy	O. K.	12
	Average	39.6	26	13				11.9
50° F	White	38	25	13	Tainted	Salvy	O. K.	11.75
	Kirkpatrick	43	29	13	Acidy	Pasty	O. K.	12.5
	Millar	41	26	13	Tainted	Salvy	O. K.	12.25
	Average	40.6	26.6	13				12.16
60° F	White	40	26	13	Tainted	Salvy	O. K.	12
	Kirkpatrick	42	27	13	Acidy	Waxy	O. K.	12.25
	Millar	41	25	13	Low	Pasty	O. K.	12.25
	Average	41	26	13				12.16

LOT 1.—A. H. BARBER & CO., MERRILL, MICH.

Second jury trial (*cheese 5 months old*).

40° F	White	40	25	10	Off	Mealy	Cut	11.5
	Millar	32	27	12	Acidy	Pasty	Cut	11.75
	Average	36	26	11				11.62
50° F	White	40	25	10	Tainted	Tallowy	Cut	11.5
	Millar	33	28	13	Acidy	Salvy	Cut	12
	Average	36.5	26.5	11.5				11.75
60° F	White	39	25	10	Off	Tallowy	Cut	11.25
	Millar	35	28	12	Acidy	Pasty	Cut	12
	Average	37	26.5	11				11.62

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type III (soft home-trade type)—Continued.

LOT 2.—A. H. BARBER & CO., MERRILL, MICH.

First jury trial (cheese 3 months old).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard 13 cents).
		Flavor (standard 45.)	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F.	White	40	26	12	Acidy	Salvy	Wavy	11.5
	Kirkpatrick	42	28	12	Flat	Pasty	Wavy	11.5
	Millar	40	25	13	Acidy	Pasty	Mottled	12.25
	Average	40.6	26.3	12.5				11.75
50° F.	White	40	27	13	Acidy	Pasty	O. K	11.75
	Kirkpatrick	43	29	13	Clean	Waxy	O. K	12
	Millar	42	27	14	Acidy	Waxy	O. K	12.5
	Average	41.6	27.6	13.3				12.08
60° F.	White	40	27	12	Acidy	Pasty	Wavy	11.75
	Kirkpatrick	40	28	13	Tainted	Salvy	O. K	11.25
	Millar	40	25	13	Acidy	Tallowy	O. K	12
	Average	40	26.6	12.6				12

LOT 2.—A. H. BARBER & CO., MERRILL, MICH.

Second jury trial (cheese 5 months old).

40° F	White	38	25	10	Acidy	Tallowy	Cut	11
	Millar	42	27	12	Acidy	Tallowy	Cut	11
	Average	40	26	11				11
50° F	White	37	25	10	Acidy	Tallowy	Cut	11
	Millar	40	26	12	Acidy	Tallowy	Cut	11
	Average	38.5	25.5	11				11
60° F	White	37	24	10	Acidy	Tallowy	Cut	11
	Millar	38	27	12	Acidy	Tallowy	Cut	11
	Average	37.5	25.5	11				11

LOT 3.—A. H. BARBER & CO., MERRILL, MICH.

First jury trial (cheese 3 months old).

40° F.	White	40	27	12	Acidy	Close	Wavy	11
	Kirkpatrick	41	28	13	Acidy	Tallowy	Cut	11.5
	Millar	40	27	14	Acidy	Tallowy	O. K	11.5
	Average	40.3	27.3	13				11.3
50° F.	White	42	28	13	Low	Smooth	Wavy	12
	Kirkpatrick	43	28	13	Clean	Tallowy	O. K	12
	Millar	42	28	14	Acidy	Smooth	O. K	12
	Average	42.6	28	13.3				12
60° F.	White	40	27	12	Bitter	Salvy		11.5
	Kirkpatrick	42	27	13	Clean	Loose	O. K	11.75
	Millar	39	25	14	Acidy	Pasty	O. K	11.25
	Average	40.3	26.3	13				11.5

SCORES BY INDIVIDUAL JUDGES AT THE COMMERCIAL TEST MADE AT FIRST AND SECOND JURY TRIALS—Continued.

Type III (*soft home-trade type*)—Continued.

LOT 3.—A. H. BARBER & CO., MERRILL, MICH.

Second jury trial (*cheese 5 months old*).

Curing temperature.	Judges.	Numerical scores.			Descriptive scores.			Price (standard 13 cents).
		Flavor (standard 45).	Texture (standard 30).	Color (standard 15).	Flavor.	Texture.	Color.	
40° F	White	40	26	14	Tainted	Smooth	O. K	11.5
	Millar	36	28	12	Tainted	Loose	O. K	11
	Average	38	27	13				11.25
50° F	White	39	25	10	Tainted	Smooth	Wavy	11.25
	Millar	40	26	12	Tainted	Loose	O. K	11.5
	Average	39.5	25.5	11				11.37
60° F	White	39	25	13	Tainted	Smooth	Specks	11.5
	Millar	38	27	12	Tainted	Loose	O. K	11.25
	Average	38.5	26	12.5				11.37

LOT 4.—A. H. BARBER & CO., MERRILL, MICH.

First jury trial (*cheese 3 months old*).

40° F	White	42	27	13	Flat	Stiff	Wavy	12
	Kirkpatrick	42	29	14	Clean	Waxy	O. K	12.5
	Millar	42	28	14	Low	Waxy	O. K	12.5
	Average	42	28	13.6				12.3
50° F	White	40	25	13	Flat	Mealy	Wavy	11.25
	Kirkpatrick	42	29	13	Clean	Pasty	O. K	12
	Millar	41	26	12	Low	Pasty	Wavy	12
	Average	41	26.6	12.6				11.75
60° F	White	41	26	12	Flat	Mealy	Cut	11.5
	Kirkpatrick	43	28	13	Clean	Mealy	Wavy	12.25
	Millar	42	27	13	Flat	Pasty	Wavy	12.25
	Average	42	27	12.6				12

LOT 4.—A. H. BARBER & CO., MERRILL, MICH.

Second jury trial (*cheese 5 months old*).

40° F	White	43	26	10	Flat	Mealy	Cut	12.25
	Millar	43	28	14	Clean	Smooth	Cut	12.25
	Average	43	27	12				12.25
50° F	White	43	27	11	Flat	Smooth	Cut	12.5
	Millar	42	28	14	Flat	Smooth	Cut	12
	Average	42.5	27.5	12.5				12.25
60° F	White	41	25	9	Flat	Mealy	Wavy	11.75
	Millar	40	25	13	Acidy	Pasty	Cut	11.75
	Average	40.5	25	11				11.75

EASTERN EXPERIMENTS, 1902-03.

Conducted by L. L. VAN SLYKE, G. A. SMITH, and E. B. HART,
Of the New York Agricultural Experiment Station.

SUMMARY.

(1) *Object of experiment.*—The investigation was undertaken by the United States Department of Agriculture in cooperation with this station, its object being to study, on a commercial scale under commercial conditions, the influence of different temperatures upon the cheese during the curing process.

(2) *Plan of experiment.*—Cheese was secured which represented the product of the States of New York, Pennsylvania, and Ohio, and placed in cold storage at the temperatures of 40°, 50°, and 60° F. These were examined commercially by a committee of experts when first placed in cold storage, and later after being in cold storage ten, twenty, twenty-eight, and thirty-five weeks. Cheeses of different sizes were used, weighing 70, 65, 45, 35, and 12½ pounds. Also, in one case, cheeses were covered with a coating of paraffin. Chemical analyses were made at intervals.

(3) *Loss of weight.*—The loss of weight increased with increase of temperature, being on an average in twenty weeks 3.8 pounds per 100 pounds of cheese at 40° F., 4.8 pounds at 50° F., and 7.8 pounds at 60° F. The large-sized cheeses lost less weight per 100 pounds than those of smaller size.

(4) *Results of scoring cheese.*—Cheese cured at 40° F. was superior in quality to the same kind cured at higher temperatures. That cured at 50° F. was superior in quality to that cured at 60° F. The general averages of the scores at the end of twenty weeks were as follows: 95.7 at 40° F., 94.2 at 50° F., and 91.7 at 60° F. The difference in quality was confined in most cases to flavor and texture, the color and finish being little or not at all affected in cheese that was in good condition at the beginning.

(5) *Effects of covering cheese with paraffin.*—The commercial qualities of cheese were favorably influenced after six months in the case of that covered with paraffin, especially in flavor. The loss of moisture was greatly lessened, amounting only to a fraction of a pound for 100 pounds of cheese at 40° F. and 50° F., and being only about one-fifth the average loss found at 60° F. with cheese not so treated. The cheeses were also perfectly clean and free from mold, while all the cheeses not treated with paraffin were covered with mold.

(6) *Results of chemical analysis.*—The amount of certain water-soluble nitrogen compounds in cheese, such as caseoses, peptones, amides, and ammonia, is used as a means for measuring chemically the degree of ripeness in cheese. The amount of water-soluble nitrogen compounds increases with the age of cheese and with the temperature at which the cheese is cured.

(7) *Some practical applications.*—Curing cheese at low temperatures increases the amount of cheese to sell by preventing loss of moisture, and covering cheese with paraffin increases still more the yield of marketable cheese. This saving amounts to several dollars a ton. Also, the improved quality of cheese cured at low temperatures gives such cheese a higher market price.

REPORT OF RESULTS OF CURING CHEESE IN COLD STORAGE.

INTRODUCTION.

On the part of the New York Agricultural Experiment Station at Geneva, the work of selecting cheese, sampling, and supervision was performed by George A. Smith, dairy expert, and L. L. Van Slyke, chemist of the station; E. B. Hart assisted in the chemical work. The New York Mercantile Exchange was requested to designate competent persons to judge the cheese upon a commercial basis, and, the subject being referred to the cheese committee of the exchange, the following members were named as trade experts for this service: C. S. Martin, representing the oldest and largest cheese house in New York; F. B. Swift, representing one of the largest cheese-exporting firms in Montreal and New York, and D. W. Whitmore, head of a well-known firm. On the part of the Department of Agriculture, B. F. Van Valkenburgh, dairy inspector, gave immediate personal supervision.

The cheese was cured in New York City and examined and scored there, from time to time, without removal from cold storage.

The plan of the experiment was to secure cheese representing the States of New York, Pennsylvania, and Ohio, to place this in cold storage at different temperatures, to have commercial examinations made from time to time by a committee of chosen experts, to weigh the cheese at intervals, and to make chemical analyses of it. The object of this work was to study during the curing process the effect of different temperatures and the effect of covering cheese with paraffin upon (1) the commercial quality of the cheese, (2) the loss of weight, and (3) the chemical changes taking place.

DESCRIPTION OF SOURCES AND CHARACTER OF DIFFERENT LOTS OF CHEESE USED IN THE EXPERIMENT.

The arrangements for carrying on the experiment were not completed until the latter part of September, when it was somewhat difficult to secure large-sized cheeses, because most of the factories were making only the small home-trade size. We were able, however, to get the makers in two cases to make the large-sized cheeses for this special work, but they were not of the best quality in every respect.

Lot I comprised 21 cheeses, averaging 64 pounds in weight, made by A. B. Hargrave at Heuvelton, St. Lawrence County, N. Y. These were made from the mixed milk of September 26, which contained 3.8 per cent of fat. The milk was ripened to 4½ spaces by the Marschall rennet test at a temperature of 86° F. Rennet extract was used at the rate of 2½ ounces for 1,000 pounds of milk. The milk began to thicken in fifteen minutes. The curd was heated to 98° F. in forty-five minutes. One hour and twenty minutes later the curd showed one-eighth of an inch of fine threads by the hot-iron test, when the whey was removed. The curd was then packed, drained, and kept for three hours, after which it was milled, salted at the rate of 2 pounds for 1,000 pounds of milk, cooled to 80° F., and put in press.

This lot of cheese was shipped to New York on September 30 and placed in cold storage on October 6.

Lot II comprised 40 boxes of cheese, made by J. E. Case at Turtlepoint, Pa., during the third week in September. They averaged 45 pounds in weight. It was found impossible to get a special lot of cheese made in Pennsylvania for this work, and so it was decided to take some already made. These cheeses were therefore older when put into cold storage, and did not get the full benefit of ripening at lower temperatures. In making the cheese, a starter of lactic ferment was used and the milk ripened to about 5 spaces by the Marschall test at a temperature of 86° F. Rennet extract was used at the rate of 2½ ounces for 1,000 pounds of milk, and the curd was cut in about forty-five minutes. The subsequent heating was carried to about 100° F. The whey was removed as soon as the curd strung on a hot iron. After milling, the curd was allowed to stand about half an hour before salting, with frequent stirring, and then cooled to 90° F. Salt was added at the rate of 2½ pounds for 1,000 pounds of milk used.

This lot of cheese was placed in cold storage on October 6.

Lot III consisted of 44 cheeses, averaging in weight about 34 pounds. They were made by J. H. Searl at Lowville, Lewis County, N. Y., from the mixed night and morning milk of September 26. Half were uncolored (A) and half were colored (B). The milk contained 4 per cent of fat and 12.6 per cent of solids. The milk was ripened to 3½ spaces by the Marschall test at 84° F. Rennet extract was used at the rate of 2½ ounces for 1,000 pounds of milk. The curd was cut in twenty-five minutes, and fifteen minutes later heat was applied, the temperature of 98° F. being reached in fifty minutes. Forty minutes later the whey was removed, as the curd showed one-eighth of an inch of string by the hot-iron test. After packing and draining in the usual way the curd was milled about four hours after the removal of whey. Salt was added at the rate of 2 pounds for 1,000 pounds of milk used, and the curd was cooled to 80° F. and then put in press.

This lot of cheese was shipped to New York October 1 and placed in cold storage October 7.

Lot IV consisted of two different sizes of cheeses, made by C. S. Alger at Martinsburg, Lewis County, N. Y. There were 20 colored cheeses (A), each weighing about 65 pounds, and 28 cheeses of so-called Stilton size or style (B), each weighing about 12½ pounds. (These are ordinarily known in market as "Young Americas.") The cheese was made from mixed milk of September 29, containing 4 per cent of fat and 12.6 per cent of solids. The conditions of manufacture were normal.

This lot of cheese was shipped on October 3 and placed in cold storage October 8.

Lot V comprised 34 cheeses, made by E. S. Rice at Triumph, Ohio, each averaging in weight about 36½ pounds. Rennet extract was added at the rate of 3 ounces for 1,000 pounds of milk at 86° F. The curd was cut in thirty minutes and then heated to 104° F. in about thirty minutes, the whey being drawn an hour and a half later. Salt was added at rate of 2¼ pounds for 1,000 pounds of milk used.

This lot was shipped October 7 and placed in cold storage October 13, 1902.

Lot VI consisted of 40 cheeses, each cheese weighing about 70 pounds. It was not at first intended to include a comparative trial between cheese in natural form and coated with paraffin (according to the increasing commercial practice), and no cheese was purchased by the Department of Agriculture for this purpose. But at the request of the New York Agricultural Experiment Station, and through the liberal cooperation of Messrs. Martin & Co., this was accomplished. Martin & Co. furnished this lot of cheese at their own expense and risk, but they were added to the five purchased lots, divided among the three curing rooms, as later recorded, and subjected to the same conditions and examinations as the rest. The cheese contained in this lot represented two different dates of manufacture one week apart—October 10 (A) and October 17 (B).

This lot of cheese was made by H. Petrie at Turin, Lewis County, N. Y. The milk, of good quality in every respect, was warmed to 86° F. and a carefully prepared sour-milk starter added. It was then ripened to about 4 spaces by the Marschall test. Rennet extract was added at the rate of 2½ ounces for 1,000 pounds of milk. In twenty-five to thirty minutes the curd was cut, the cutting being somewhat fine, after which careful stirring was begun and continued until the pieces of curd were well separated and beginning to shrink. Heat was then applied, the temperature of 98° F. being reached in about forty-five minutes. Stirring was continued until the curd strung on the hot iron one-eighth of an inch, when the whey was removed. The curd was then matted, cut into pieces about 3 by 6 by 6 inches, and turned at intervals of six or eight minutes until the curd was well drained and solid. The curd was then piled until it acquired a smooth, velvety feeling, after which it was milled, spread out, stirred, and cooled until fat started from it when squeezed in the hand. It was then salted at the rate of 2 pounds for 1,000 pounds of milk used, and finally put in press. Light pressure was applied at first—just enough to make the curd hold together in the form of the mold. At the end of one hour the cheeses were removed from the hoops, the cloths and outside of the cheeses rinsed with warm water, replaced in press, and pressure applied for eighteen hours.

This lot was placed in cold storage October 24, half of the number being covered with paraffin (Ap and Bp) and half being in natural condition (An and Bn).

LENGTH OF EXPERIMENT.

In February the cheese stored at 60° F. was removed and sold. In April the cheese stored at 50° F. was placed on the market, and also most of the cheese kept at 40° F. Some of the cheese that had been held at 40° F. was retained and kept until June 1, when it was sold, except some that was kept and placed at a temperature of 32° F. for further work.

DISTRIBUTION OF CHEESES IN COLD STORAGE.

Arrangements were made with the Merchants' Refrigerating Company of New York City to provide special rooms and take care of these different lots of cheese. Rooms were provided in which the temperatures could be controlled and kept at 40° F., 50° F., and 60° F. Automatic records were arranged in each room, showing the condition of the temperature continuously. The regulation of temperatures was remarkably well done; the variations from the desired point, for the entire period of storage, did not exceed 2° for the 60° room or 1° for the other rooms. It was an exceptionally good piece of work in maintaining even temperatures for thirty or forty successive weeks.

The different lots of cheese were distributed in the different temperatures in the manner indicated by the following table:

Distribution of cheese at different temperatures.

Lot.		Number and weight of cheeses at 40° F.		Number and weight of cheeses at 50° F.		Number and weight of cheeses at 60° F.	
		Number.	*Pounds.*	*Number.*	*Pounds.*	*Number.*	*Pounds.*
I		10	645	6	384	5	325
II		18	811	12	535	10	448
III	White	11	378	6	207	5	170
	Colored	11	371	6	204	5	171
IV	Large	9	585	6	387	5	329
	Stiltons	16	197	8	99	4	50
V		19	696	8	290	7	256
VI	An	5	358	3	211	2	143
	Ap	5	356	3	212	2	142
	Bn	5	352	....	....	....	....
	Bp	5	358	3	208	2	138

LOSS OF WEIGHT.

The following table gives the weights of the cheese kept at the different temperatures and the percentages of loss at the several dates stated:

Weights of cheese and percentages of loss at different temperatures.

Lot and description.	Date of weighing.	Room at 40° F.		Room at 50° F.		Room at 60° F.	
		Weight.	Loss.	Weight.	Loss.	Weight.	Loss.
		Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
I (New York export Cheddars)	Oct. 6	645	....	384	....	325	....
	Feb. 13	616	4.5	367	4.4	303	6.8
	Apr. 10	611	5.3	361	6.0	....	....
	June 1	600	7.0	....	....	....	....
II (Pennsylvania Cheddars)	Oct. 7	811	....	535	....	448	....
	Feb. 13	789	2.7	515	3.7	425	1
	Apr. 10	783	3.5	511	4.5	....	....
	June 1	774	4.5	....	....	....	....
III A (white)	Oct. 7	378	....	207	....	170	....
	Feb. 13	362	4.2	195	5.8	155	8.8
	Apr. 10	357	5.6	192	7.2	....	....
III B (colored)	Oct. 7	371	....	204	....	171	....
	Feb. 13	360	3.0	193	5.4	157	8.2
	Apr. 10	355	4.3	189	7.4	....	....
	June 1	348	6.2	....	....	....	....
IV A (large)	Oct. 8	585	....	387	....	329	....
	Feb. 13	559	4.4	366	5.4	305	7.3
	Apr. 10	554	5.3	365	5.7	....	....
	June 1	545	6.8	....	....	....	....
IV B (Stiltons, or Young Americas)	Oct. 8	197	....	99	....	50	....
	Feb. 13	188	4.6	91	8.1	44	12.0
	Apr. 10	184	6.6	88	11.1	....	....
	June 1	179	9.1	....	....	....	....
V (Ohio flats)	Oct. 13	696	....	290	....	656	....
	Feb. 13	664	4.6	271	6.6	233	9.0
	Apr. 10	658	5.5	266	8.3	....	....
	June 1	646	7.2	....	....	....	....
VI An (Export Cheddars, without paraffin)	Oct. 24	358	....	211	....	143	....
	Feb. 13	349	2.5	206	2.4	137	4.2
	Apr. 10	346.7	3.1	202.7	4.0	....	....
	June 1	342	4.5	....	....	....	....
VI Ap (Same, paraffined)	Oct. 24	356	....	212	....	142	....
	Feb. 13	355	0.3	211	0.5	140	1.4
	Apr. 10	354	0.6	210	0.9	....	....
	June 1	352.8	0.9	....	....	....	....
VI Bn (New York Cheddars, without paraffin)	Oct. 24	352	....	....	....	....	....
	Feb. 13	340	3.4	....	....	....	....
	Apr. 10	336.5	4.4	....	....	....	....
	June 1	333.2	5.3	....	....	....	....
VI Bp (Same, paraffined)	Oct. 24	358	....	208	....	138	....
	Feb. 13	357	0.3	207	0.5	136	1.5
	Apr. 10	356.6	0.4	207	0.5	....	....
	June 1	355.4	0.7	....	....	....	....

Showing weight lost by cheese.

Lot.	Average weight of each cheese.	Age when placed in cold storage.	Age when weighed.	Amount lost for 100 pounds of cheese—		
				At 40° F.	At 50° F.	At 60° F.
	Pounds.	*Days.*	*Weeks.*	*Pounds.*	*Pounds.*	*Pounds.*
I	64	9	20	4.5	4.4	6.8
I	64	9	28	5.3	6.0	....
I	64	9	35	7.0	....	....
II	45	18	20	2.7	3.7	5.1
II	45	18	28	3.5	4.5	....
II	45	18	35	4.5	....	....
III A	34	9	20	4.2	5.8	8.8
III A	34	9	28	5.6	7.2	....
III B	34	9	20	3.0	5.4	8.2
III B	34	9	28	4.3	7.4	....
III B	34	9	35	6.2	....	....
IV A	65	8	20	4.4	5.4	7.3
IV A	65	8	28	5.3	5.7	....
IV A	65	8	35	6.8	....	....
IV B	12.5	8	20	4.6	8.1	12.0
IV B	12.5	8	28	6.6	11.1	....
IV B	12.5	8	35	9.1	....	....
V	36.5	....	19	4.6	6.6	9.0
V	36.5	....	27	5.5	8.3	....
V	36.5	....	34	7.2	....	....
VI An	70	7	17	2.5	2.4	4.2
VI An	70	7	25	3.1	4.0	....
VI An	70	7	32	4.5	....	....
VI Ap	70	7	17	0.3	0.5	1.4
VI Ap	70	7	25	0.6	0.9	....
VI Ap	70	7	32	0.9	....	....
VI Bn	70	14	17	3.4	....	....
VI Bn	70	14	25	4.4	....	....
VI Bn	70	14	32	5.3	....	....
VI Bp	70	14	17	0.3	0.5	1.5
VI Bp	70	14	25	0.4	0.5	....
VI Bp	70	14	32	0.7	....	....

From the data contained in the above table, we are enabled to make the following statements:

(1) The cheese continued to lose water in nearly every case as long as weighings were made. This was true of all temperatures.

(2) The loss of weight was least at 40° F. and increased with increase of temperature. At the end of twenty weeks the cheese in temperature 40° F. had lost on an average 3.8 pounds per 100; that in 50° F., 4.8 pounds; and that in 60° F., 7.8 pounds. The loss at temperature 40° F. was 1 pound less than at 50° F., and 4 pounds less than at 60° F. In other words, the loss at 60° F., as compared with the loss at 50° F., was three times as great as was the loss at 50° F., compared with the loss at 40° F. The loss of weight was proportionally greater at higher temperatures.

(3) If we determine the average weekly loss from the data given in this table, we find that during the first twenty weeks the loss was at the average rate of 3 ounces a week at 40° F., 3.8 ounces at 50° F., and 6.2 ounces at 60° F. From the twentieth to the twenty-eighth week the average weekly loss was 2.2 ounces at 40° F. and 3.2 ounces at 50° F. The cheese kept at 40° F. appeared to lose more moisture per week from April 10 to June 1 than previously.

(4) The size of cheese influences the loss of moisture. Small cheeses, other conditions being the same, lose a larger proportion of moisture in curing than do large cheeses, owing to the greater amount of surface relative to weight in the smaller cheeses. This tendency is shown by the following tabulated statement:

Weight lost per 100 pounds of cheese in twenty weeks.

Average weight of cheese.	At 40° F.	At 50° F.	At 60° F.
Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
70	2.5	2.4	4.2
45	2.7	3.7	5.1
35	3.9	5.9	8.5
12¼	4.6	8.1	12.0

It will be noticed that the variation is much less at 40° than at the higher temperature.

(5) The method of covering cheese with paraffin greatly reduces the loss of moisture. In VI An and Bn the cheeses were in natural condition, while in VI Ap and Bp they were covered with paraffin, being dipped in melted paraffin when a few days old. The loss of moisture in cheese covered with paraffin was only 0.3 pound per 100 pounds of cheese in twenty weeks at 40° F., 0.5 pound at 50° F., and 1.4 pounds at 60° F. In the same kind of cheese not thus covered the loss of moisture was much greater at all temperatures. By covering cheese with paraffin a saving in loss of moisture can be effected amounting to 5 or 6 pounds per 100 pounds of cheese at 60° F., and at 50° or below the total loss of moisture can be reduced to less than 1 pound per 100 pounds of cheese. In addition, the use of paraffin prevents the growth of molds. In every case cheeses covered with paraffin were entirely clean, while the others were more or less heavily coated with molds.

RESULTS OF COMMERCIAL EXAMINATION OF CHEESE.

Arrangements were made to have the cheese examined at intervals by the commercial experts already named, who were to score the cheeses separately, the basis of a perfect cheese being 50 for flavor, 25 for texture, 15 for color, and 10 for finish. We give the average of the scores in the following table:

Results of scoring of cheese.

Lot.	Date of examination.	Temperature of curing room.	Flavor.	Texture.	Color.	Finish.	Total score.	Remarks.
		°*F.*						
I	Oct. 6, 1902	....	48	24	15	10	97	
	Dec. 15, 1902	40	48	24	15	10	97	
	.....do......	50	46.5	23	15	10	94.5	
	.....do......	60	46	22	15	10	93	
	Feb. 13, 1903	40	46.7	23.3	15	10	95	
	.....do......	50	44.3	23	14.7	10	92	
	.....do......	60	42.7	22	14.3	10	89	
	Apr. 10, 1903	40	46.3	23	14.7	10	94	Flavor not perfectly clean.
	.....do......	50	44.7	22.7	14.6	10	92	Flavor somewhat tainted.
	June 1, 1903	40	48	24.7	15	10	97.7	Clean flavor and silky texture.
II	Oct. 6, 1902	....	48	24	15	10	97	
	Dec. 15, 1902	40	48	23.5	15	10	96.5	
	.....do......	50	48	23	15	10	96	
	.....do......	60	47	22.5	15	10	94.5	
	Feb. 13, 1903	40	46	22	15	10	93	
	.....do......	50	45	22	15	10	92	
	.....do......	60	44	22	15	10	91	
	Apr. 10, 1903	40	45.7	22.3	15	10	93	Flavor not perfectly clean.
	.....do......	50	43.7	22.3	14.7	10	90.7	Flavor tainted.
	June 1, 1903	40	46	23	15	10	94	Flavor flat; texture smooth and silky.
III	Oct. 7, 1902	....	48	24	15	10	97	
	Dec. 15, 1902	40	48.5	24	15	10	97.5	
	.....do......	50	48	24	15	10	97	
	.....do......	60	46.5	33	15	10	94.5	
	Feb. 13, 1903	40	47.7	23.7	15	10	96.4	Flavor clean; texture wax-like.
	.....do......	50	47.7	24	15	10	96.7	
	.....do......	60	45.3	23.3	14.8	10	94.4	
	Apr. 10, 1903	40	47.7	24	15	10	96.7	
	.....do......	50	46.7	23.7	15	10	95.4	Flavor slightly bitter.
	June 1, 1903	40	47	24	15	10	96	Flavor clean; texture smooth and silky.
IV A	Oct. 8, 1902	....	47	23	14	10	94	Rather acid and of imperfect color.
	Dec. 15, 1902	40	47.5	23.5	14	10	95	
	.....do......	50	46.5	22.5	13.5	10	92.5	
	.....do......	60	44.5	22	13.5	10	90	
	Feb. 13, 1903	40	44.7	22.7	13.3	10	90.7	
	.....do......	50	42.3	22	12.3	10	86.6	
	.....do......	60	41.7	21.3	12	10	85	
	Apr. 10, 1903	40	46	23	14.7	10	93.7	Flavor acid; texture stiff.
	.....do......	50	43.3	22	13	10	88.3	Flavor acid and not clean; texture harsh; color imperfect.
	June 1, 1903	40	46	23	12.7	10	91.7	Flavor clean; texture smooth and silky; color light.

Results of scoring of cheese—Continued.

Lot.	Date of examination	Temperature of curing room.	Flavor.	Texture.	Color.	Finish.	Total score.	Remarks.
		°F.						
IV B	Oct. 8, 1902	....	48	23	15	10	96	
	Dec. 15, 1902	40	48	23.5	15	10	96.5	
	.....do......	50	47.5	23.5	15	10	96	
	.....do......	60	46.5	22.5	15	10	94	
	Feb. 13, 1903	40	47.3	23.7	15	10	96	
	.....do......	50	45	22	15	10	92	
	.....do......	60	44	22	15	10	91	
	Apr. 10, 1903	40	46.3	24.3	15	10	95.6	
	.....do......	50	46.3	24	14.7	10	95	
	June 1, 1903	40	46.7	23.3	15	10	95	Flavor clean; texture wax-like.
V	Oct. 13, 1902	....	46	23	15	10	94	
	Dec. 15, 1902	40	46.5	23.5	15	10	95	
	....do.......	50	45	22.5	15	10	92.5	
	....do.......	60	40.5	20.5	15	10	86	
	Feb. 13, 1903	40	45.3	21.3	14.7	10	91.7	
	....do.......	50	43.7	20.3	14.7	10	88.7	
	....do.......	60	43	20	14.7	10	87.7	
	Apr. 10, 1903	40	45.3	22	14.7	10	92	Flavor and texture imperfect.
	....do.......	50	44	21.7	14.3	10	90	Slightly bitter and of weak texture.
	June 1, 1903	40	46	22.7	15	10	93.7	Flavor clean; texture smooth and pasty.
VI. An	Dec. 15, 1902	40	49	24	15	10	98	
	....do.......	50	48.5	23.5	15	10	97	
	....do.......	60	48	23.5	15	10	96.5	
	Feb. 13, 1903	40	48	24	15	10	97	
	....do.......	50	48	24	15	10	97	
	....do.......	60	45.3	23	15	10	93.3	
	Apr. 10, 1903	40	48	24	15	10	97	
	....do.......	50	48	24	15	10	97	
	June 1, 1903	40	47.7	24.3	15	10	97	Surface covered with mold.
VI. Ap	Feb. 13, 1903	40	48	24	15	10	97	
	....do.......	50	48	24	15	10	97	
	....do.......	60	46.3	23.3	15	10	94.3	
	Apr. 10, 1903	40	48.3	24	15	10	97.3	
	....do.......	50	48	24	15	10	97	
	June 1, 1903	40	48.7	24.3	15	10	98	Condition practically perfect; surface bright and clear.
VI. Bn	Feb. 13, 1903	40	48	24	15	10	97	
	....do.......	50	48	24	15	10	97	
	....do.......	60	44.7	22.7	14.3	10	91.7	
	Apr. 10, 1903	40	48	24	15	10	97	
	....do.......	50	47	24	15	10	96	
	June 1, 1903	40	47.7	24.3	15	10	97	Surface covered with mold.
VI. Bp	Feb. 13, 1903	40	48	24	15	10	97	
	....do.......	50	48	24	15	10	97	
	....do.......	60	45.7	23	15	10	93.7	
	Apr. 10, 1903	40	48	24	15	10	97	
	....do.......	50	47	24	15	10	96	
	June 1, 1903	40	48.7	24.3	15	10	98	Condition practically perfect; surface bright and clean.

SUMMARY.

From the data embodied in the preceding table, we are able to present the following statements as a summary of the results:

(1) Almost without exception the cheese cured at lower temperatures was superior in quality to that cured at higher temperatures. Cheese cured at 40° F. usually scored higher than that cured at 50° F., and the cheese cured at 50° F. scored higher in every instance than that cured at 60° F. Averaging all our results, we have the following general scores for the different temperatures: At 40° F., 95.7; at 50° F., 94.2; at 60° F., 91.7. From these figures we see that the cheese deteriorated considerably more at 60° F. as compared with 50° F. than it did at 50° F. as compared with 40° F. The difference of scores is 1.5 in favor of 40° F., as compared with 50° F., and 2.5 in favor of 50° F. as compared with 60° F. In other words, the higher the temperature the greater is the relative deterioration of cheese in quality for each degree of temperature.

(2) The difference in quality fell mostly on the flavor and texture. Averaging all the figures, we have the following results:

Averages of flavor and texture.

Qualities.	At 40° F.	At 50° F.	At 60° F.
Flavor	47.4	46.4	44.8
Texture	23.4	23	22.2

Here also we see that the difference is greater between 60° and 50° F. than between 50° and 40° F. in the direction of poorer quality.

(3) At any given time the cheese cured at 40° F. was usually better in quality than that at 50°, and that at 50° was better than that at 60°. The longer the time of curing the greater was the difference in favor of the lower temperatures. The following tabulated averages of the results illustrate the statements:

Averages for different ages.

Age of cheese.	Score at 40° F.	Score at 50° F.	Score at 60° F.
Weeks.			
10	96.3	94.7	92
20	93.8	91.5	89.7
28	94.2	91.9	....
35	95.3	....	....

The cheese cured at 60° showed such deterioration in quality at the end of twenty weeks that it was sold. While the cheese cured at 40° and 50° showed some deterioration in quality at twenty weeks, it scored higher at twenty-eight weeks than at twenty weeks. The cheese kept at 40° showed its highest score at thirty-five weeks in several cases.

The higher score was always in favor of the lower temperature by several points.

(4) The effect of covering cheese with paraffin was in several cases to improve the quality as compared with cheese not so covered. The difference was more marked at 60° than at lower temperatures. The cheese covered with paraffin and cured at 40° showed its highest score at the end of thirty-five weeks.

Results of use of paraffin.

Character of cheese.	Age in weeks.	At 40° F.	At 50° F.	At 60° F.
Cheese, normal (An)	20	97	97	93.3
Cheese, normal (Bn)	20	97	97	91.7
Cheese covered with paraffin (Ap)	20	97	97	94.3
Cheese covered with paraffin (Bp)	20	97	97	93.7
Cheese, normal (An)	28	97	97	....
Cheese, normal (Bn)	28	97	96	....
Cheese covered with paraffin (Ap)	28	97.3	97	....
Cheese covered with paraffin (Bp)	28	97	96	....
Cheese, normal (An and Bn)	35	97	....	....
Cheese covered with paraffin (Ap and Bp)	35	98	....	....

RESULTS OF CHEMICAL ANALYSIS OF CHEESE.

The analytical data upon which the following discussion of chemical results is based were obtained by the methods described in Bulletin No. 215 of the New York Agricultural Experiment Station, and the table giving these data in full may be found in Bulletin No. 234 of the same series. But in this work the paranuclein, caseoses, and peptones were not separated from one another, their combined amount being obtained by difference.

(1) *The process of cheese ripening.*—When cheese ripens, the most prominent change taking place is in the nitrogen compounds. The casein of milk is changed by the action of rennet enzyme into curd, chemically known as paracasein. In the process of cheese making, lactic acid is formed and this unites with the paracasein, forming a compound known as paracasein monolactate.[a] It is this compound that imparts to cheese curd the property of forming fine strings on a hot iron, and it is the formation of this paracasein monolactate that accounts for the changes in appearance, plasticity, and texture of cheese curd during the process of cheddaring. However, there is reason to believe that the changes that take place in the process of cheese-ripening start with and are dependent upon the presence of paracasein monolactate or some similar compound. Hence, from a chemical point of view, cheese ripening consists mainly of the change of paracasein monolactate into other forms of nitrogen compounds, chief among which in the order of their formation are paranuclein, caseoses, peptones, amido compounds, and ammonia. These com-

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[a] Bull. No. 214, N. Y. Agricultural Experiment Station.

pounds, formed from paracasein monolactate, are readily soluble in water, while paracasein monolactate is not. Hence, in ripened cheese we have larger amounts of substances that are soluble and smaller amounts of substances that are insoluble. Ripened cheese is for this reason believed to be more readily digestible than green cheese. The amount of soluble nitrogen compounds is used as a measure of the extent of cheese ripening.

This present investigation offers an opportunity for studying the chemical results of cheese ripening under different conditions of temperature and with a number of different types of Cheddar cheese under commercial conditions.

(2) *Moisture in cheese.*—Before taking up a study of the nitrogen compounds of the cheese under investigation we will call attention to the amount of moisture in the cheese.

In the case of lots I, II, III, and IV, in which the moisture was determined when the cheese was placed in cold storage, the moisture content was found to vary from 34.20 to 35.44 per cent; this may be regarded as a comparatively small variation. In lots IV and V the moisture must have been above 40 per cent at the time the cheese was placed in cold storage, because ten weeks later, when the first analysis was made, the moisture was about 39 per cent. The result of moisture determination shows a gradual decrease in moisture as the cheese becomes older, as indicated by the following averages:

Per cent of moisture in cheese.

	At 40° F.	At 50° F.	At 60° F.
When put in cold storage	36.50	36.50	36.50
After being in storage ten weeks	36.30	35.70	35.65
After being in storage twenty weeks	35.35	34.66	34.26

The decrease of moisture is greater with increase of temperature, a point which has been dwelt upon in connection with loss of weight.

(3) *Amount of paracasein monolactate in cheese.*—The amount of paracasein monolactate formed in the different cheeses when one and two weeks old varied from 40.70 to 66.14 per cent of the nitrogen in the cheese and averaged 57.49 per cent. The amount decreased as the cheese aged, and more rapidly at higher than at lower temperatures, as shown by the following general averages:

Percentage of nitrogen in cheese in form of paracasein monolactate.

Age of cheese.	At 40° F.	At 50° F.	At 60° F.
1 week	57.49	57.49	57.49
10 weeks	47.94	42.08	37.09
20 weeks	47.10	35.24	30.77
28 weeks	40.54	31.82	
35 weeks	36.36		

This diminution of paracasein monolactate is undoubtedly due to its conversion into water-soluble nitrogen compounds.

(4) *Amount of water-soluble nitrogen compounds in cheese.*—While the amount of water-soluble compounds of nitrogen in cheese is not a guide in respect to the detailed chemical changes taking place in ripening cheese, it serves as a general indication of the extent and rapidity of those changes. The data below, representing averages of our results, show that the amount of water-soluble nitrogen increases with increase of temperature and with lapse of time:

Percentage of nitrogen in cheese in form of water-soluble compounds.

Age of cheese.	At 40° F.	At 50° F.	At 60° F.
1 week	14.65	14.55	14.55
10 weeks	20.03	25.18	28.48
20 weeks	24.12	31.56	36.24
28 weeks	26.27	33.00	....
35 weeks	27.64	....	....

(5) *Amount of amido compounds in cheese.*—The amido compounds of cheese are of interest because it is possible that among these compounds we are to look for the substance or substances responsible for cheese flavors. Little or no cheese flavor appears in cheese until amido compounds are formed. The amount of amido compounds increases with temperature and with lapse of time, as shown by the following averages:

Percentage of nitrogen in cheese in form of amido compounds.

Age of cheese.	At 40° F.	At 50° F.	At 60° F.
1 week	4.06	4.06	4.06
10 weeks	6.92	8.98	9.85
20 weeks	5.53	8.95	13.30
28 weeks	7.60	12.70	....
35 weeks	9.00	....	....

(6) *Amount of ammonia in cheese.*—The formation of ammonia compounds in cheese may possibly be associated also with the development of cheese flavor. No ammonia is found in fresh cheese. It begins to be formed in appreciable quantities in about four weeks and increases with the age of the cheese. Its amount is greater at higher than at lower temperatures. The following averages give a good idea of the amount found in cheese under the conditions indicated:

Percentage of nitrogen in cheese in form of ammonia.

Age of cheese.	At 40° F.	At 50° F.	At 60° F.
1 week	0	0	0
10 weeks	1.20	1.87	1.97
20 weeks	1.62	3.44	3.36
28 weeks	2.52	3.48	....

SOME PRACTICAL APPLICATIONS.

From the data presented in the foregoing pages, we have seen that the use of low temperatures in curing cheese shows two prominent results—(1) reduction of loss of weight and (2) improvement of commercial quality. Any reduction in loss of weight or any improvement in quality means an increase in the amount of money that can be realized in the sale of the cheese. It is a matter of practical interest and importance to consider in detail what specific increased or decreased market values were found for the cheese under the different conditions of experiment.

ECONOMY IN REDUCING LOSS OF MOISTURE.

We have seen that the loss of moisture in curing cheese can be reduced by using a lower temperature, or by covering cheese with a thin coating of paraffin, or by a combination of these two conditions.

Increased amount of cheese resulting from using low temperatures.—Taking the longest period of time for which we were able to compare the results at the different temperatures employed (twenty weeks), it was found that the cheese cured at 40° F. had lost, on an average, 3.8 pounds for 100 pounds of cheese; the cheese at 50° F. had lost 4.8 pounds, and that at 60° F. 7.8 pounds. For 100 pounds of cheese originally placed in the curing rooms at the different temperatures, we had for sale at the end of twenty weeks 96.2 pounds of cheese cured at 40° F., 95.2 pounds cured at 50° F., and 92.2 pounds cured at 60° F.

Assuming that the cheese sells at a uniform price of 10 cents a pound, there would be receipts from the original 100 pounds of each of the different cheeses as follows:

Cheese cured at 40° F	$9.62
Cheese cured at 50° F	9.52
Cheese cured at 60° F	9.22

Under these conditions, the receipts from the cheese kept at 40° F. are 10 cents per 100 pounds more than for that kept at 50° F. and 40 cents per 100 pounds more than that kept at 60° F. As will be pointed out later, the differences are really greater than this.

Increased amount of cheese resulting from covering cheese with a coating of paraffin.—At the end of seventeen weeks, cheese covered with paraffin had lost only 0.3 pound for 100 pounds of cheese originally placed in storage at 40° F., 0.5 pound at 50° F., and 1.4 pounds at 60° F. The saving thus effected, based on the uniform price of cheese at 10 cents a pound, would average about 35 cents for 100 pounds of cheese cured at 40° F., 43 cents for 100 pounds at 50° F., and 64 cents for 100 pounds at 60° F.; or, comparing cheese kept at 40° F., covered with paraffin, with cheese kept at 60° F. not so covered, there would be a difference of about 75 cents per 100 pounds in favor of the paraffined cheese.

The cost of covering cheese with paraffin is slight. Conveniences for the work can be obtained from manufacturers of dairy supplies.

Increased value resulting from improvement in quality of cheese cured at low temperatures.—We have already studied the results of the scores furnished by the experts who examined the cheese from time to time. They were requested also to place upon the different lots of cheese a commercial valuation based upon the results of their scoring. Below we present these commercial valuations in tabulated form. The experts properly disregarded the actual market rates, which have fluctuations sometimes difficult to account for, and established as their constant basis of valuation 13 cents per pound for cheese scoring over 95 points.

Value of one pound of cheese.

Date of examination.	Temperature curing room.	Lot I.	Lot II.	Lot III.	Lot IV.		Lot V.	Lot VI.			
					A.	B.		An.	Ap.	Bn.	Bp.
	° F.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Dec. 15, 1902.	40	13	13	13	13	13	13	13.75	13.75	13.75	13.75
Do.......	50	12.75	13	13	12.50	13	12.50	13.75	13.75	13.75	13.75
Do.......	60	12.50	12.75	12.75	12	12.75	11.75	13.75	13.75	13.75	13.75
Feb. 13, 1903.	40	13	12.50	13	12	13	12.25	14.25	14.25	14.25	14.25
Do.......	50	12.25	12.25	13	11.75	12.25	12	14.25	14.25	14.25	14.25
Do.......	60	12	12.25	12.50	11.75	12.25	11.75	13.50	13.75	13.25	13.50
Apr. 9, 1903..	40	12.75	12.50	13	12.50	13	12.50	14.75	14.75	14.75	14.75
Do.......	50	12.25	12.25	13	12	13	12.25	14.50	14.75	14.50	14.75
June 1, 1903..	40	....	....	....	....	....	....	14.50	14.50	14.75	14.75

In studying the data embodied in this table, the following points are noticeable:

(1) In the case of lots I to V, the value of the cheese cured at 40° F. was greater in most cases than that cured at 50° F., and in every case greater than that cured at 60° F. In most cases, the cheese cured at 50° F. had a higher value than that cured at 60° F. These statements hold good for the twenty weeks during which the cheeses were kept at the three different temperatures. If the cheese cured at 60° F. had been kept for a longer period, it would have shown serious decrease in value.

In the case of lot VI, the value was the same for all temperatures on December 15, when the cheese was about eight weeks old. And this lot was of so much better quality that it was assigned a value above the 13-cent basis, in proportion to its score above 95 points. Two months later, there was no difference at the temperature of 40° and 50° F., but the cheese kept at 60° had a lower value than the cheese kept at the lower temperatures. In April, when the cheese was about twenty-five weeks old, there was a little difference in favor of the lower temperatures.

(2) In comparing the cheese covered with paraffin (lot VI, Ap and Bp) with that left in natural condition (lot VI, An and Bn), there was no difference in their value during the first seventeen weeks at the temperatures 40° and 50° F. At 60° F., at the end of seventeen weeks, the cheese covered with paraffin was valued at a quarter of a cent a pound more than the unparaffined. When the cheese kept at 40° F. was twenty-five and thirty-two weeks old, there was no difference in value between the paraffined cheese and that not paraffined; but in the cheese kept at 50° F. there was, at the end of twenty-five weeks, an increased value of a quarter of a cent a pound in favor of the paraffined cheese. It thus appears that the results are more marked at higher temperatures than at lower temperatures in favor of the paraffined cheese, but even then only after the first few months of ripening. The chief value of paraffining cheese appears to be in preventing loss of moisture and in keeping the surface of the cheese free from molds.

(3) If we average the results obtained with the different lots of cheese, we have the following figures:

Value per pound of cheese cured at different temperatures.

Date of examination.	At 40° F.	At 50° F.	At 60° F.
	Cents.	*Cents.*	*Cents.*
Dec. 15, 1902	13.300	13.175	12.950
Feb. 13, 1903	13.275	13.050	12.675
Apr. 9, 1903	13.525	13.325	....

At the end of ten weeks the cheese cured at 40° F. was worth 12½ cents more per 100 pounds than the cheese cured at 50° F. and 35 cents more than that cured at 60° F. The cheese cured at 50° F. was worth 22½ cents per 100 pounds more than that cured at 60° F.

At the end of twenty weeks the cheese cured at 40° F. was worth 22½ cents more per 100 pounds than the cheese cured at 50° F. and 60 cents more than that cured at 60° F., while that cured at 50° F. was worth 37½ cents per 100 pounds more than that cured at 60° F.

At the end of twenty-eight weeks the cheese cured at 40° F. was worth 20 cents more per 100 pounds than that cured at 50° F.

Increased receipts from cheese cured at low temperatures and covered with paraffin.—We have seen that the curing of cheese at low temperatures has the effect of (1) preventing loss of moisture and (2) increasing the value of the cheese. Therefore, we not only have more cheese to sell but can sell it at a higher price. Taking cheese twenty weeks old as a basis for comparison, we know how much weight is lost at different temperatures and also the difference in price. From these figures the following tabulated statement is given:

Money returns at several temperatures.

Temperature of curing.	Cured cheese equivalent to 100 pounds of green cheese.	Market price of 1 pound of cheese.	Receipts from cheese.
° *F.*	*Pounds.*	*Cents.*	*Dollars.*
40	96.2	13.275	12.77
50	95.2	13.050	12.42
60	92.2	12.675	11.69

These figures indicate that from 100 pounds of green cheese put into the curing room we were able to realize from that cured at 40° F. 35 cents more than from cheese cured at 50° F., and $1.08 more than from that cured at 60° F. From the cheese cured at 50° F. we received 73 cents more a hundred pounds than from that cured at 60° F.

If we compare our results obtained with cheese covered with paraffin with those given by cheese not so covered, we have the following tabulated statement:

Cured cheese equivalent to 100 pounds of green cheese and comparative value of that paraffined and unparaffined.

Temperature of curing room.	Cured cheese equivalent to 100 pounds of green cheese.		Value of 1 pound of cheese.		Receipts from cheese.	
	Paraffined.	Not paraffined.	Paraffined.	Not paraffined.	Paraffined.	Not paraffined.
° *F.*	*Pounds.*	*Pounds.*	*Cents.*	*Cents.*	*Dollars.*	*Dollars.*
40	99.7	96.2	14.25	14.25	14.21	13.70
50	99.5	95.2	14.25	14.25	14.19	13.56
60	98.6	92.2	13.75	13.50	13.56	12.45

At 40° F. the difference in favor of the paraffined cheese is 51 cents for 100 pounds of cheese originally placed in the curing room; at 50° F. the difference is 63 cents, and at 60° F., $1.11. Covering cheese with paraffin results in greater saving at higher temperatures than at lower temperatures.

Comparing paraffined cheese cured at 40° F. with unparaffined cheese cured at 60° F., we find a difference of $1.76 for 100 pounds of cheese in favor of the paraffined cheese and the lower temperature.

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[Continued from 2d page of cover.]

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 50.

D. E. SALMON, D. V. M., Chief of Bureau.

GERMAN MEAT REGULATIONS.

WITH ORIGINAL TEXT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

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[a] Transferred, August 16, 1902, to U. S. Public Health and Marine-Hospital Service, as Chief of Division of Zoology, but remains also in temporary charge of Zoological Division, Bureau of Animal Industry.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 50.

D. E. SALMON, D. V. M., Chief of Bureau.

GERMAN MEAT REGULATIONS.

WITH ORIGINAL TEXT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., July 15, 1903.

Sir: For the information of American packers and exporters the German meat-inspection law of June 3, 1900, was translated into English and published, in both German and English, by this Bureau, as Circular 32, and was reprinted on pages 523–534, Seventeenth Annual Report of the Bureau (for the year 1900).

Regulations and proclamations have been issued which have a direct bearing upon the law, and in response to requests the following official German documents of this nature are published herewith for the information of interested exporters.

This work has been translated by Miss Annette M. Dye, of this Bureau, under the direction of Dr. Ch. Wardell Stiles, zoologist in charge.

In order to obviate the appearance of giving an *interpretation* to these documents the translator has found it necessary to hold as closely as possible to a literal translation, taking into consideration those conditions in Germany which differ from certain conditions in America. Accordingly, English rhetoric has been made secondary to a rendering of the original German into English. Nevertheless, there are some words and expressions in the original which may not be entirely clear and the interpretation of which must rest with the German authorities.

D. E. Salmon,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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GERMAN MEAT REGULATIONS.

[TRANSLATION.]

PROCLAMATIONS OF THE SENATE.

PROCLAMATION

With regard to the ordinance concerning fees for the inspection of meat imported past the customs line, the meat-inspection customs ordinance, and the marking of inspected foreign meat.

The senate in the following again makes known to the public the ordinance resolved upon by the Bundesrath concerning fees for the inspection of meat imported past the customs line, the meat-inspection customs ordinance resolved upon by the Bundesrath, and the proclamation issued by the imperial chancellor (Reichskanzler) concerning the marking of inspected foreign meat.

Drawn up in the session of the senate, Hamburg, March 4, 1903.

PROCLAMATION.

With regard to the ordinance concerning fees for the inspection of meat imported past the customs line.

In accordance with the regulation in § 22, No. 3, of the law concerning the inspection of food animals and of meat of June 3, 1900 (Reichs-Gesetzbl., p. 547), the Bundesrath has resolved upon the following ordinance concerning fees:

Ordinance concerning fees

For the inspection of meat imported past the customs line.

§ 1.

For the inspection of meat imported past the customs line taking place in accordance with the law concerning the inspection of food animals and of meat of June 3, 1900 (Reichs-Gesetzbl., p. 547), fees are to be paid by the possessor of the meat according to the following regulations. These fees include especially also the compensations for the taking and sending of samples, for reports, entering in the inspection books, making out of certificates, marking of the meat, and any necessary travel of the experts.

GERMAN MEAT REGULATIONS.

[ORIGINAL.]

BEKANNTMACHUNGEN DES SENATS.

BEKANNTMACHUNG,

betreffend die Gebührenordnung für die Untersuchung des in das Zollinland eingehenden Fleisches, die Fleischbeschau-Zollordnung und die Kennzeichnung des untersuchten ausländischen Fleisches.

Der Senat bringt nachstehend die von dem Bundesrat beschlossene Gebührenordnung für die Untersuchung des in das Zollinland eingehenden Fleisches, die von dem Bundesrat beschlossene Fleischbeschau-Zollordnung und die von dem Reichskanzler erlassene Bekanntmachung, betreffend die Kennzeichnung des untersuchten ausländischen Fleisches, noch besonders zur öffentlichen Kenntnis.

Gegeben in der Versammlung des Senats, Hamburg, den 4. März 1903.

BEKANNTMACHUNG,

betreffend die Gebührenordnung für die Untersuchung des in das Zollinland eingehenden Fleisches.

Auf Grund der Bestimmung im § 22 Nr. 3 des Gesetzes, betreffend die Schlachtvieh- und Fleischbeschau, vom 3. Juni 1900 (Reichs-Gesetzbl., S. 547), hat der Bundesrat nachstehende Gebührenordnung beschlossen.

Gebührenordnung

für die Untersuchung des in das Zollinland eingehenden Fleisches.

§ 1.

Für die auf Grund des Gesetzes, betreffend die Schlachtvieh- und Fleischbeschau, vom 3. Juni 1900 (Reichs-Gesetzbl., S. 547), stattfindende Untersuchung des in das Zollinland eingehenden Fleisches sind von dem Besitzer des Fleisches Gebühren nach Massgabe der nachstehenden Bestimmungen zu entrichten. Diese Gebühren umfassen insbesondere auch die Vergütungen für die Entnahme und Versendung von Proben, für Benachrichtigungen, Eintragungen in die Beschaubücher, Ausstellung von Befundscheinen, Kennzeichnung des Fleisches und etwa notwendige Reisen der Sachverständigen.

§ 2.

The fees, irrespective of the fees established for special inspections in §§ 4 to 6, amount to—

A. In the case of *fresh* meat:

	Marks.
(1) For neat cattle (exclusive of calves) or for reindeer, per head	2.50
(2) For a calf	.75
(3) For a swine or wild boar	.75
(4) For a sheep or a goat	.60
(5) For a horse or some other animal of the soliped genus (ass, mule, hinny)	3.00

B. In the case of *prepared* meat (except fat):

(6) For casings, per kilogram	.010
(7) For bacon, per kilogram	.020
(8) For other prepared meat, per kilogram	.025

However, for casings at least 0.40 mark, for other prepared meat at least 0.50 mark, are to be collected for every shipment.

In the case of assorted shipments (§ 12, paragraph 3, of the regulations D, concerning the carrying out of the law), or when in the case of the condemnation of a sample [taken at random], the examination is carried out with reference to the ground of condemnation through the entire homogeneous shipment (§ 12, paragraph 4, of the regulations above referred to) the fees established under B, Nos. 6 to 8, are to be paid to double the amount.

Pfennig amounts [other than multiples of 5] in the final total are to be rounded out to the next higher number divisible by 5.

§ 3.

If the preparation of the meat for inspection (taking out of the viscera, detaching of the leaf fat, cutting of the swine into halves, hanging up or laying out [arranging] of the portions of flesh in the inspection room) is not made by the person having the right to receive [the wares] or provided for by him, for this work an additional amount of 20 per cent of the inspection fees established according to § 2 is to be collected. Pfennig amounts [other than multiples of 5] in the final total are to be rounded out to the next higher number divisible by 5.

§ 4.

The fees for the inspection for *trichina* amount to—

	Mark.
(1) For an entire swine or wild boar	1.00
(2) For meat, with the exception of bacon (e. g., ham, piece of pickled meat, and the like), per piece	.50
(3) For bacon, per piece	.35

For the assistance of the trichina inspector in inspection for measle worm [*Cysticercus*] special fees are not to be collected.

§ 2.

Die Gebühren betragen, abgesehen von den in den §§ 4 bis 6 für besondere Untersuchungen festgesetzten Gebühren,

A. bei frischem Fleische:

1) für ein Stück Rindvieh (ausschliesslich der Kälber) oder ein Renntier	2,50 M.,
2) für ein Kalb	0,75 “
3) für ein Schwein oder Wildschwein	0,75 “
4) für ein Schaf oder eine Ziege	0,60 “
5) für ein Pferd oder ein anderes Tier des Einhufergeschlechts (Esel, Maultier, Maulesel)	3,00 “

B. bei zubereitetem Fleische (ausgenommen Fett):

6) von Därmen für jedes Kilogramm	0,01 M.,
7) von Speck für jedes Kilogramm	0,02 “
8) von sonstigem zubereiteten Fleische für jedes Kilogramm	0,025 “.,

Jedoch sind von Därmen mindestens 0,40 M., von sonstigem zubereiteten Fleische mindestens 0,50 M. für jede Sendung zu erheben.

Bei nicht gleichartigen Sendungen (§ 12 Abs. 3 der Ausführungsbestimmungen D) oder wenn im Falle der Beanstandung einer Stichprobe die Untersuchung in bezug auf den Beanstandungsgrund an der ganzen gleichartigen Sendung ausgeführt wird (§ 12 Abs. 4 ebenda) sind die unter B Nr. 6 bis 8 festgesetzten Gebühren in doppelter Höhe zu entrichten.

Pfennigbeträge bei der Endsumme sind auf eine durch 5 teilbare Zahl nach oben abzurunden.

§ 3.

Erfolgt die Herrichtung des Fleisches für die Beschau (Herausnahme der Eingeweide, Loslösen der Liesen, Zerlegung der Schweine in Hälften, Aufhängen oder Auflegen der Fleischteile im Untersuchungsraume) nicht durch den Empfangsberechtigten oder eine von ihm zur Verfügung gestellte Hülfskraft, so wird für diese Arbeiten noch ein Zuschlag von 20 Prozent zu den nach Massgabe des § 2 festgesetzten Untersuchungsgebühren erhoben. Pfennigbeträge bei der Endsumme sind auf eine durch 5 teilbare Zahl nach oben abzurunden.

§ 4.

Die Gebühren für die Untersuchung auf Trichinen betragen:

1) für ein ganzes Schwein oder Wildschwein	1,00 M.,
2) für ein einzelnes Stück Fleisch, ausgenommen Speck (z. B. Schinken, Stück Pökelfleisch und dergleichen)	0,50 “
3) für ein Stück Speck	0,35 “.

Für die Hülfeleistung der Trichinenschauer bei der Finnenschau sind besondere Gebühren nicht zu erheben.

§ 5.

Without prejudice to the fees collected according to § 6, the fees for the *chemical* examination of *prepared* meat, fat excepted, amount to 0.02 mark, for the *chemical* examination of *prepared fats*, including the preliminary test, 0.01 mark per kilogram of a homogeneous shipment (§ 12, paragraph 3, of the regulations D, concerning the carrying out of the law). However, the minimum fee for chemical examination of meat amounts to 1 mark, for that of fats 0.40 mark for every package of the shipment. In the case of assorted shipments, or when in case of condemnation of a sample [taken at random] the examination with reference to the ground of condemnation is undertaken for the entire homogeneous shipment (§ 12, paragraph 4, of the regulations D, concerning the carrying out of the law), double the fees are to be paid.

Pfennig amounts [other than multiples of 5] in the final total are to be rounded out to the next higher number divisible by 5.

§ 6.

For the chemical examination of prepared meat for [to determine] the presence of horse meat (§ 14, paragraph 3, under *a* of the regulations D, concerning the carrying out of the law), when the suspicion is confirmed by the examination, a fee of 0.15 mark for every kilogram of the shipment is collected. For the examination of hams in shipments under 10 pieces, of bacon and of casings, likewise of fresh meat for [to determine] the presence of the materials mentioned in § 5, No. 3, of the regulations D, concerning the carrying out of the law (§ 14, paragraph 3, under *b*, § 13, paragraph 2, of the regulations D, concerning the carrying out of the law), under the same condition, a fee of 0.05 mark is to be paid for every kilogram of the shipment.

The minimum fee for inspection for [to determine] the presence of horse meat amounts to 15 marks, that for the examination for [to determine] the presence of the prohibited materials 2.50 marks for one shipment.

§ 7.

In so far as the fees for inspection are to be calculated according to the weight of the wares, the net weight is to be used as a basis. For the purpose of determining this weight, so far as [in case] it is not obtained directly by weighing, the procedure is to be according to the regulations prescribed for the determination of the net weight by the customs office. The gross weight for this purpose is to be taken from the declaration, so far as the statements may be considered as reliable and sufficient.

In so far as the weight determined by the customs office is already known at the time of the calculating of the fees, it can be used as a basis for the latter.

§ 5.

Unbeschadet der nach Massgabe des § 6 zur Erhebung gelangenden Gebühren betragen die Gebühren für die chemische Untersuchung von zubereitetem Fleische, ausgenommen Fett, 0,02 M., für die chemische Untersuchung von zubereitetem Fette, einschliesslich der Vorprüfung, 0,01 M. für jedes Kilogramm einer gleichartigen Sendung (§ 12 Abs. 3 der Ausführungsbestimmungen D). Jedoch beträgt die Mindestgebühr bei der chemischen Untersuchung von Fleisch 1 M., bei der von Fetten 0,40 M. für jedes Packstück der Sendung. Bei nicht gleichartigen Sendungen, oder wenn im Falle der Beanstandung einer Stichprobe die Untersuchung in bezug auf den Beanstandungsgrund an der ganzen gleichartigen Sendung vorgenommen wird (§ 12 Abs. 4 der Ausführungsbestimmungen D), sind die doppelten Gebühren zu entrichten.

Pfennigbeträge bei der Endsumme sind auf eine durch 5 teilbare Zahl nach oben abzurunden.

§ 6.

Für die chemische Untersuchung von zubereitetem Fleische auf das Vorhandensein von Pferdefleisch (§ 14 Abs. 3 unter *a* der Ausführungsbestimmungen D) wird, wenn der Verdacht durch die Untersuchung bestätigt wird, eine Gebühr von 0,15 M. für jedes Kilogramm der Sendung erhoben. Für die Untersuchung von Schinken in Sendungen unter 10 Stück, von Speck und von Därmen, desgleichen von frischem Fleische auf die Anwesenheit der im § 5 Nr. 3 der Ausführungsbestimmungen D genannten Stoffe (§ 14 Abs. 3 unter b, § 13 Abs. 2 der Ausführungsbestimmungen D) ist unter der gleichen Bedingung eine Gebühr von 0,05 M. für jedes Kilogramm der Sendung zu entrichten.

Die Mindestgebühr bei der Untersuchung auf das Vorhandensein von Pferdefleisch beträgt 15 M. diejenige bei der Untersuchung auf die Anwesenheit der verbotenen Stoffe 2,50 M. für eine Sendung.

§ 7.

Insoweit die Untersuchungsgebühren nach dem Gewichte der Ware zu berechnen sind, ist das Nettogewicht zu Grunde zu legen. Behufs Ermittelung dieses Gewichts ist, soweit nicht eine Nettoverwiegung eintritt, nach den für die zollamtliche Ermittelung des Nettogewichts vorgeschriebenen Bestimmungen zu verfahren. Das Bruttogewicht kann zu diesem Zwecke aus der Deklaration entnommen werden, sofern die Angaben als zuverlässig und ausreichend anzuseben sind.

Insoweit das zollamtlich ermittelte Gewicht zur Zeit der Gebührenberechnung bereits bekannt ist, kann es der letzteren zu Grunde gelegt werden.

§ 8.

In case the shipment is voluntarily withdrawn (§ 12, paragraph 6, of the regulations D, concerning the carrying out of the law), upon the ground of the condemnation of a sample [taken at random], the fees established in § 2 under B, Nos. 6 to 8, and those established in § 4 are to be collected only for that part of the shipment upon which the examinations in question are already made up to the time of withdrawal. In so far as only inspections of samples [taken at random] have taken place, of the total fees to be calculated for the entire shipment according to § 2 under B, Nos. 6 to 8, that proportional amount is to be collected which corresponds to the relation of the number of the samples inspected to the total number of the samples taken.

In similar case only half of the fees established in § 5 are to be collected, when up to the time of the withdrawal not more than half of the samples taken for the purpose of the chemical examination of the meat or for the principal test of the fat are examined. The single samples are considered as examined even when only one of the tests described in the directions for the chemical examination of meat and fats is made. If more than half of the samples are already examined the full fees are to be collected for the entire shipment.

§ 9.

The determination and fixing of the costs devolving upon the complainant for an unfounded complaint, in the case of § 30, paragraph 1, of the regulations D, concerning the carrying out of the law, takes place according to the ordinances issued with regard thereto by the [separate] federated governments.

§ 10.

The authorities may require before the beginning of the examination the payment of a suitable deposit to be determined by them. If in the cases of § 6 the suspicion is proved unfounded, or the shipment is voluntarily withdrawn (§ 8), the corresponding amounts are to be paid back.

THE IMPERIAL CHANCELLOR (REICHSKANZLER),
COUNT V. POSADOWSKY, *Acting.*

BERLIN, *July 12, 1902.*

§ 8.

Falls die Sendung auf Grund der Beanstandung einer Stichprobe freiwillig zurückgezogen wird (§ 12 Abs. 6 der Ausführungsbestimmungen D), sind die im § 2 unter B Nr. 6 bis 8 und die im § 4 festgesetzten Gebühren nur von demjenigen Teile der Sendung zu erheben, an welchem die betreffenden Untersuchungen zur Zeit der Zurückziehung bereits ausgeführt sind. Insoweit nur Stichproben-Untersuchungen stattgefunden haben, ist von der für die Gesamtsendung nach § 2 unter B Nr. 6 bis 8 zu berechnenden Gebührensumme derjenige Teilbetrag zu erheben, welcher dem Verhältnisse der Zahl der untersuchten Stichproben zu der Gesamtzahl der entnommenen Stichproben entspricht.

Im gleichen Falle sind die im § 5 festgesetzten Gebühren nur zur Hälfte zu erheben, wenn zur Zeit der Zurückziehung nicht mehr als die Hälfte der zum Zwecke der chemischen Untersuchung des Fleisches oder zur Hauptprüfung des Fettes entnommenen Proben untersucht ist. Die einzelnen Proben gelten schon dann als untersucht, wenn auch nur eine der in der Anweisung für die chemische Untersuchung von Fleisch und Fetten beschriebenen Prüfungen ausgeführt ist. Ist bereits mehr als die Hälfte der Proben untersucht, so sind die vollen Gebühren von der ganzen Sendung zu erheben.

§ 9.

Die Bemessung und Festsetzung der im Falle des § 30 Abs. 1 der Ausführungsbestimmungen D dem Beschwerdeführer zur Last fallenden Kosten einer unbegründeten Beschwerde erfolgt nach Massgabe der hierüber ergehenden Anordnungen der Landesregierungen.

§ 10.

Die Behörde kann die Einzahlung eines angemessenen von ihr zu bestimmenden Vorschusses vor Beginn der Untersuchung verlangen. Wenn in den Fällen des § 6 der Verdacht als unbegründet sich erweist, oder die Sendung freiwillig zurückgezogen wird (§ 8), sind die entsprechenden Beträge zurückzuzahlen.

BERLIN, *den 12. Juli 1902.*

DER REICHSKANZLER.
In Vertretung: GRAF V. POSADOWSKY.

The Bundesrath in its session of January 29 of this year resolved to approve the following printed meat-inspection customs ordinance:

V. FISCHER.

BERLIN, *February 5, 1903.*

By authority of the Imperial Chancellor.

Meat-inspection customs ordinance.

I. *Limitations of importation and shipment in [direct] transit.*

§ 1.

The following can not be imported past the customs line:

1. Meat in hermetically sealed cans or similar vessels, sausages and other mixtures of chopped meat (§12, paragraph 1, of the law concerning the inspection of food animals and of meat of June 3, 1900 [Reichs-Gesetzbl., p. 547], and § 5, No. 1, of the regulations D issued by the Bundesrath concerning that law).

2. Dog meat as well as prepared meat which comes from horses, asses, mules, hinnies, or other animals of the soliped genus (§ 15 of the law and § 5 No. 2, of the regulations D concerning the carrying out of the law).

3. Meat which has been treated with one of the following materials or with a preparation containing such materials—

(*a*) Boracic acid and its salts.

(*b*) Formaldehyde.

(*c*) Alkali and alkaline earth hydroxides and carbonates.

(*d*) Sulphurous acid and its salts as well as hyposulphites.

(*e*) Hydrofluoric acid and its salts.

(*f*) Salicylic acid and its compounds.

(*g*) Chlorates.

(*h*) Dyes of all kinds, however, without prejudice to their use for coloring margarine yellow and for the coloring of sausage skins, in so far as this use does not contravene other provisions

(§ 21 of the law and § 5, No. 3, of the regulations D concerning the carrying out of the law).

4. Fresh meat which with reference to the size (entire carcasses and half carcasses) and to the connection with [possession of] internal organs and other portions of the body does not comply with the provisions of § 12, paragraph 2, No. 1, of the law as well as of § 6 of the regulations D concerning the carrying out of the law.

5. Fresh horse meat which is not made recognizable as horse meat by a designation in the German language (§ 18, paragraph 2, of the law).

Der Bundesrat hat in seiner Sitzung vom 29. Januar d. J. beschlossen, der nachstehend abgedruckten Fleischbeschau-Zollordnung die Zustimmung zu erteilen.

BERLIN, *den 5. Februar 1903.*

DER REICHSKANZLER.
Im Auftrage: v. FISCHER.

Fleischbeschau-Zollordnung.

I. *Beschränkungen der Ein- und Durchfuhr.*

§ 1.

In das Zollinland dürfen nicht eingeführt werden:

1. Fleisch in luftdicht verschlossenen Büchsen oder ähnlichen Gefässen, Würste und sonstige Gemenge aus zerkleinertem Fleische (§ 12 Abs. 1 des Gesetzes, betreffend die Schlachtvieh- und Fleischbeschau, vom 3. Juni 1900 [Reichs-Gesetzbl., S. 547] und § 5 Ziffer 1 der dazu vom Bundesrat erlassenen Ausführungsbestimmungen D);

2. Hundefleisch, sowie zubereitetes Fleisch, welches von Pferden, Eseln, Maultieren, Mauleseln oder anderen Tieren des Einhufergeschlechts herrührt (§ 15 des Gesetzes und § 5 Ziffer 2 der Ausführungsbestimmungen D);

3. Fleisch, welches mit einem der folgenden Stoffe oder mit einer solche Stoffe enthaltenden Zubereitung behandelt worden ist:

a) Borsäure und deren Salze,

b) Formaldehyd,

c) Alkali- und Erdalkali-Hydroxyde und -Karbonate,

d) Schweflige Säure und deren Salze sowie unterschwefligsaure Salze,

e) Fluorwasserstoff und dessen Salze,

f) Salicylsäure und deren Verbindungen,

g) Chlorsaure Salze,

h) Farbstoffe jeder Art, jedoch unbeschadet ihrer Verwendung zur Gelbfärbung der Margarine und zum Färben der Wursthüllen, sofern diese Verwendung nicht anderen Vorschriften zuwiderläuft (§ 21 des Gesetzes und § 5 Ziffer 3 der Ausführungsbestimmungen D);

4. Frisches Fleisch, das in bezug auf die Grösse (ganze und halbe Tierkörper) und auf den Zusammenhang mit inneren Organen und sonstigen Körperteilen den Vorschriften des § 12 Abs. 2 Ziffer 1 des Gesetzes sowie des § 6 der Ausführungsbestimmungen D nicht entspricht;

5. Frisches Pferdefleisch, das nicht durch eine Bezeichnung in deutscher Sprache als Pferdefleisch erkennbar gemacht ist (§ 18 Abs. 2 des Gesetzes);

6. Pickled (salted) meat in pieces of less weight than 4 kilograms, with the exception of hams, bacon, and casings (§ 12, paragraph 2, No. 2, of the law and § 7, paragraph 1, of the regulations D concerning the carrying out of the law).

§ 2.

What wares fall under the above prohibitions is determined according to the regulations in §§ 1 to 4, and § 7, paragraph 2, of the regulations D concerning the carrying out of the law.

§ 3.

Shipment in direct transit under custom-house escort or under customs seal, in postal traffic also without these means of control is not to be considered as importation in the sense of the above regulations.

As shipment in direct transit, only that transportation of wares is to be considered which is accomplished without a longer stay in the inland than is made necessary for the proper transportation of wares. A shipment in direct transit especially does not obtain in the case of storage of the wares in a customs warehouse under official seal (§ 10 of the regulations D concerning the carrying out of the law).

§ 4.

The importation prohibitions of § 1, Nos. 1, 2, 4 to 6, do not apply:

1. To meat which in the case of § 26 is reimported from the inland through a region outside the customs line to a point inside the customs line.

2. To meat which is taken along for use on a journey. Here belongs especially meat which is taken by sea ships as ship provisions from the country outside the customs line and is not removed from the ship; meat which is in excess of the probable need of the crew during the remaining of the ship in the inland is to be placed under customs seal; customs seal may be omitted when the ship is under special customs surveillance (§ 14, paragraph 1, of the law, and § 4, paragraph 1, last sentence of the regulations D concerning the carrying out of the law).

3. To meat inspected according to the regulations, that has been sent from the inland to the country outside the customs line, from there returns in unchanged condition and is left free of the importation duty.

4. To meat which is not intended for food for man, under the condition that it is made unfit for use as food in the prescribed way (§ 21).

6. Pökel-(Salz-)Fleisch in Stücken von geringerem Gewicht als 4 kg., ausgenommen Schinken, Speck und Därme (§ 12 Abs. 2 Ziffer 2 des Gesetzes und § 7 Abs. 1 der Ausführungsbestimmungen D).

§ 2.

Welche Waren unter die vorstehenden Verbote fallen, regelt sich nach den Bestimmungen in den §§ 1 bis 4 and § 7 Abs. 2 der Ausführungsbestimmungen D.

§ 3.

Die unmittelbare Durchfuhr unter zollamtlicher Begleitung oder unter Zollverschluss, im Postverkehr auch ohne diese Kontrolmittel, ist als Einfuhr im Sinne der vorstehenden Bestimmungen nicht zu betrachten.

Als unmittelbare Durchfuhr ist nur derjenige Warendurchgang anzusehen, der sich vollzieht ohne längere Aufenthaltsdauer im Inland, als durch die ordnungsmässige Warenbeförderung bedingt ist. Eine unmittelbare Durchfuhr liegt insbesondere nicht vor bei Aufbewahrung der Waren in einem Zollager unter amtlichem Verschlusse (§ 10 der Ausführungsbestimmungen D).

§ 4.

Die Einfuhrverbote des § 1 Ziffer 1, 2, 4 bis 6 finden keine Anwendung:

1. auf Fleisch, welches im Falle des § 26 vom Inlande durch das Ausland nach dem Inlande versendet wird;

2. auf Fleisch, welches zum Reiseverbrauche mitgeführt wird. Hierher gehört insbesondere Fleisch, welches von Seeschiffen als Schiffsproviant aus dem Zollauslande mitgeführt und nicht vom Schiffe entfernt wird; das Fleisch, welches den mutmasslichen Bedarf der Schiffsmannschaft während der Dauer des Aufenthalts des Schiffes im Inland übersteigt, ist unter zollamtlichen Verschluss zu setzen; von der Verschlussanlage kann abgesehen werden, wenn das Schiff unter besonderer Zollbewachung steht (§ 14 Abs. 1 des Gesetzes und § 4 Abs. 1 letzter Satz der Ausführungsbestimmungen D);

3. auf vorschriftsmässig untersuchtes Fleisch, das aus dem Inlande nach dem Zollauslande gesendet worden ist, von da in unverändertem Zustande zurückkommt und vom Eingangszolle freigelassen wird;

4. auf Fleisch, welches nicht zum menschlichen Genusse bestimmt ist, unter der Voraussetzung, dass es in der vorgeschriebenen Weise ungeniessbar gemacht wird (§ 21).

§ 5.

To meat imported in the minor frontier trade as well as in trade at fairs and markets in the frontier district the importation prohibitions of § 1 apply in so far as the [separate] federated governments do not grant exceptions to the prohibitions mentioned in § 1, Nos. 1, 2, 4 to 6 (§ 14, paragraph 2, of the law, and § 9 of the regulations D concerning the carrying out of the law).

§ 6.

If before the examination of the meat by the inspection office the suspicion arises among the customs authorities that, either intentionally or through negligence, an importation prohibition is contravened, the customs authorities shall place a provisional embargo upon the wares and notify the state attorney, so that in accordance with §§ 26 to 28 of the law punitive proceedings may be instituted or the independent confiscation can be brought about.

§ 7.

If there is not present the suspicion of an intentional violation or a violation through negligence of an importation prohibition, the meat imported contrary to the prohibition is to be taken back to the outland under customs surveillance. In place of reexportation the destruction of the wares shall take place under customs surveillance, when the person having charge of the wares agrees to the destruction or refuses to provide for the reexportation of the wares to the outland.

If the meat is spoiled or if there is other cause for objections on the part of the sanitary or veterinary police, the police authorities are to be informed so that the necessary protective measures may be taken.

The procedure shall be according to the above provisions also when, in the case of § 6, the confiscation of the meat is not ordered by the state attorney or is refused by the court.

If contraventions of an importation prohibition are not discovered until the examination of the meat by the inspection office, the confiscation devolves upon the inspection office, who shall immediately inform the customs authorities of this (§ 24 of the regulations D, concerning the carrying out of the law).

II. *Procedure in the importation of meat.*

§ 8.

The importation of meat may take place only through the customs offices designated by the Bundesrath. In how far the authority of the head offices thus designated may be exercised by the independent dis-

§ 5.

Auf das im kleinen Grenzverkehre sowie im Mess- und Marktverkehre des Grenzbezirkes eingehende Fleisch finden die Einfuhrverbote des § 1 Anwendung, soweit die Landesregierungen nicht von den im § 1 Ziffer 1, 2, 4 bis 6 bezeichneten Verboten Ausnahmen zulassen (§ 14 Abs. 2 des Gesetzes und § 9 der Ausführungsbestimmungen D).

§ 6.

Entsteht vor der Untersuchung des Fleisches durch die Beschaustelle bei der Zollbehörde der Verdacht, dass einem Einfuhrverbote wissentlich oder fahrlässig zuwidergehandelt ist, so hat die Zollbehörde die Ware vorläufig in Beschlag zu nehmen und die Staatsanwaltschaft zu benachrichtigen, damit auf Grund der §§ 26 bis 28 des Gesetzes das Strafverfahren eingeleitet oder die selbständige Einziehung des Fleisches herbeigeführt werden kann.

§ 7.

Liegt der Verdacht einer wissentlichen oder fahrlässigen Verletzung eines Einfuhrverbots nicht vor, so ist das verbotswidrig eingeführte Fleisch unter zollamtlicher Überwachung in das Ausland zurückzuschaffen. An Stelle der Wiederausfuhr hat die Vernichtung der Ware unter zollamtlicher Mitaufsicht zu erfolgen, wenn der Verfügungsberechtigte mit der Vernichtung einverstanden ist oder es ablehnt, für die Zurückschaffung der Waren in das Ausland zu sorgen.

Ist das Fleisch verdorben oder gibt es sonst zu gesundheits- oder veterinärpolizeilichen Bedenken Verlanlassung, so ist die Polizeibehörde behufs Ergreifung der erforderlichen Sicherungsmassregeln zu benachrichtigen.

Nach den vorstehenden Vorschriften ist auch zu verfahren, wenn im Falle des § 6 die Einziehung des Fleisches von der Staatsanwaltschaft nicht beantragt oder vom Gericht abgelehnt wird.

Werden Zuwiderhandlugen gegen ein Einfuhrverbot erst bei der Untersuchung des Fleisches durch die Beschaustelle entdeckt, so liegt die Beschlagnahme der Beschaustelle ob, welche hiervon der Zollbehörde sofortige Mitteilung zu machen hat (§ 24 der Ausführungsbestimmungen D).

II. *Verfahren bei der Einfuhr von Fleisch.*

§ 8.

Die Einfuhr von Fleisch darf nur über die vom Bundesrate bestimmten Zollstellen erfolgen. Inwieweit die Befugnisse der danach zuständigen Hauptämter von den an deren Sitzen befindlichen

patching offices located at their place is determined by the authorities of the [separate] federated governments.

The importation of meat may be limited in given places to certain days by the [separate] federated governments.

In postal trade (§ 24), as well as in the case of meat taken along for use on journeys (§ 11, No. 1), meat may be imported through all the frontier customs offices, [and] in the case of shipment in direct transit (§ 11, No. 2), and in case of § 26, [meat may be imported] through all the frontier customs offices provided with the necessary authority [customs clearance authority].

§ 9.

Meat imported past the customs line is subject to an official examination (inspection) with cooperation of the customs authorities, whose competency is determined by § 8, paragraph 1.

What is to be considered as meat in the sense of this customs ordinance is regulated according to the general provisions in §§ 1 to 4 of the regulations D, concerning the carrying out of the law.

§ 10.

Meat which is proved to have been already inspected in the inland according to regulations, and that has been carried outside the customs line, is not subjected to official inspection in case it is reimported in an unchanged condition. As being proved to have been inspected according to regulations is not regarded such foreign meat as has been examined at an inspection office situated outside the customs line [Zollausland] and which, without being first brought to a proper customs office for clearance according to § 26, has been shipped through a region outside the frontier [Ausland] to [a point] within the customs line [Inlande].

§ 11.

Further, the following are not subject to inspection:

1. Meat taken by travelers for use on a journey. Here belongs especially meat taken along by sea ships as ship provisions, so far as [in case] it is not removed from the ship; meat which is in excess of the probable need of the crew during the ship's stay in the inland is to be placed under customs seal; the customs seal may be omitted when the ship is under special customs surveillance.

2. Meat intended for shipment in direct transit.

Shipment in direct transit which is to be expressly proposed in the the customs papers shall take place on Permit [Begleitschein] I or on

selbständigen Abfertigungsstellen ausgeübt werden, bestimmen die Landesbehörden.

Die Einfuhr von Fleisch kann von den Landesbehörden bei einzelnen Stellen auf bestimmte Tage beschränkt werden.

Im Postverkehre (§ 24) sowie im Reiseverkehre (§ 11 Ziffer 1) darf Fleisch über sämmtliche, bei der unmittelbaren Durchfuhr (§ 11 Ziffer 2) und im Falle des § 26 über alle mit den entsprechenden Zollabfertigungsbefugnissen versehenen Grenzzollämter eingehen.

§ 9.

Das in das Zollinland eingeführte Fleisch unterliegt einer amtlichen Untersuchung (Beschau) unter Mitwirkung der Zollbehörden, auf deren Zuständigkeit der § 8 Abs. 1 entsprechende Anwendung findet.

Was als Fleisch im Sinne dieser Zollordnung anzusehen ist, regelt sich nach den allgemeinen Vorschriften in den §§ 1 bis 4 der Ausführungsbestimmungen D.

§ 10.

Das nachweislich im Inlande bereits vorschriftsmässig untersuchte und nach dem Zollauslande verbrachte Fleisch ist im Falle der Zurückbringung in unverändertem Zustande der amtlichen Untersuchung nicht unterworfen. Als nachweislich vorschriftsmässig untersucht gilt nicht solches ausländisches Fleisch, welches bei einer im Zollauslande belegenen Beschaustelle untersucht und ohne vorher einer zuständigen Zollstelle zur Abfertigung nach Massgabe des § 26 vorgeführt zu sein, durch das Ausland nach dem Inlande versendet worden ist.

§ 11.

Der Untersuchung unterliegt ferner nicht:

1. das von Reisenden zum Verbrauch auf der Reise mitgeführte Fleisch. Hierher gehört insbesondere das von Seeschiffen als Schiffsproviant mitgeführte Fleisch, sofern es nicht vom Schiffe entfernt wird; das Fleisch, welches den mutmasslichen Bedarf der Schiffsmannschaft während der Dauer des Aufenthalts des Schiffes im Inland übersteigt, ist unter zollamtlichen Verschluss zu setzen; von der Verschlussanlage kann abgesehen werden, wenn das Schiff unter besonderer Zollbewachung steht;

2. das zur unmittelbaren Durchfuhr bestimmte Fleisch.

Die unmittelbare Durchfuhr, welche im Zollpapier ausdrücklich zu beantragen ist, hat auf Begleitschein I oder Begleitzettel und unter

a permit-slip [Begleitzettel] and under customs seal, and indeed, in so far as possible, in a sealed compartment. In place of sealing for shorter journeys custom-house escort may be substituted. The permits [Begleitscheine] or permit-slips [Begleitzettel] made out for such meat shipments receive on the upper border of the first page the mark "meat inspection" to be made with a colored pencil or by means of stamping. In the records of these permits [Begleitscheine] or permit-slips [Begleitzettel] in a proper place the same mark is to be made.

In the case of shipment in direct transit by post the making out of a permit as well as customs seal or custom-house escort may be omitted.

§ 12.

Meat imported in the small frontier trade as well as in trade at fairs and markets in the frontier district is subject to inspection according to this customs ordinance so far as the [separate] federated governments do not grant exceptions in accordance with § 14, paragraph 2, of the law.

§ 13.

In the case of importation of meat subject to inspection the person having charge of the wares has the choice as to whether he will have the examination undertaken at the frontier inspection office, when there is present at that place an authorized office for the examination that is to be made, or whether he shall have it made at another competent inspection office in the interior.

Upon the entry [of the wares] he shall notify the customs office in writing to what inspection office he wishes the examination of the meat delegated. When according to the customs regulations a written declaration of wares has to take place, the notification is to be made in this.

If the notification does not take place within a period to be fixed once for all by the frontier office and if reexportation is not asked for the examination shall be made officially at the frontier inspection office, or, in case there is at this place no inspection office authorized for examination, at a neighboring inspection office to be designated by the [frontier] office.

§ 14.

If the examination takes place at the frontier office, first of all a custom-house inspection [revision] shall take place. How far the latter is to be extended the director of the customs office shall determine; however, at least the number and kind of the packages is always to be established.

zollamtlichem Verschluss, und zwar nach Möglichkeit unter Raumverschluss, zu erfolgen. An Stelle des Verschlusses kann auf kürzere Strecken zollamtliche Begleitung treten. Die über derartige Fleischsendungen ausgestellten Begleitscheine oder Begleitzettel erhalten am oberen Rande der ersten Seite den mit Buntstift oder durch Stempelabdruck zu bewirkenden Vermerk "Fleischbeschau." In die über diese Begleitscheine oder Begleitzettel geführten Register ist an geeigneter Stelle derselbe Vermerk aufzunehmen.

Bei der unmittelbaren Durchfuhr mit der Post kann von der Ausstellung eines Begleitscheins sowie von der Anlegung eines Zollverschlusses oder von zollamtlicher Begleitung abgesehen werden.

§ 12.

Das im kleinen Grenzverkehre sowie im Mess- und Marktverkehre des Grenzbezirkes eingehende Fleisch unterliegt der Untersuchung nach Massgabe dieser Zollordnung, soweit die Landesregierungen nicht auf Grund des § 14 Abs. 2 des Gesetzes Ausnahmen zulassen.

§ 13.

Bei der Einfuhr beschaupflichtigen Fleisches hat der Verfügungsberechtigte die Wahl, ob er die Untersuchung bei der Beschaustelle des Eingangsamts, sofern daselbst eine für die vorzunehmende Untersuchung befugte Stelle vorhanden ist, oder bei einer anderen zuständigen Beschaustelle im Innern vornehmen lassen will.

Er hat bei dem Eingange der Zollstelle schriftlich anzumelden, welcher Beschaustelle er die Untersuchung des Fleisches zu übertragen wünscht. Wenn nach den zollrechtlichen Bestimmungen eine schriftliche Warendeklaration zu erfolgen hat, so ist die Anmeldung in dieser zu bewirken.

Erfolgt die Anmeldung nicht innerhalb einer von dem Eingangsamt ein für allemal anzuordnenden Frist, und wird nicht die Wiederausfuhr beantragt, so ist die Untersuchung bei der Beschaustelle des Eingangsamts oder, falls sich bei diesem eine zur Untersuchung befugte Beschaustelle nicht befindet, bei einer benachbarten, von dem Amte zu bestimmenden Beschaustelle von Amts wegen vorzunehmen.

§ 14.

Findet die Untersuchung beim Eingangsamte statt, so ist zunächst eine zollamtliche Revision der Ware vorzunehmen. Wie weit diese auszudehnen ist, bestimmt der Vorstand der Zollstelle; doch ist stets mindestens die Zahl und Art der Packstücke festzustellen.

Wares subject to meat inspection remain until the end and, in case of § 15, paragraph 3, until the beginning of the examination under customs seal, or in case this can not be accomplished they may, with the permission of the director of the head office, remain under customs surveillance.

The custom-house inspections [revisions] of fresh meat to be undertaken according to paragraph 1 take precedence over those of other wares presented at the same time in so far as § 27 of the customs law [Vereinszollgesetz] does not prevent. The customs inspection [revision] takes place at a regular customs office. Upon application it may be granted by the director of the customs office that it shall be undertaken at other places (for example, at the [meat] inspection office). Such a permission is to be granted only when at these places there are suitable rooms available in which the wares may be kept under customs seal until the end of the revision and inspection, or under customs surveillance in case the director of the head office has granted this according to the previous paragraph.

§ 15.

As soon as the wares subject to inspection arrive the customs office shall inform the [meat] inspection office of this, so far as [in case] in connection with the latter there are no regular times [established] once for all for the inspection and taking of samples (paragraph 2).

The [meat] inspection office undertakes—so far as possible immediately following upon the customs inspection [revision]—the prescribed examination of the meat, takes out the samples necessary for inspection, whose weight is to be established by the customs office, and receives the accompanying papers at hand concerning the shipment. The reception of the samples and of the accompanying papers it shall recognize in a transfer book kept by the customs office according to Model I. [For Model 1, see p. 26].

It is permissible to convey the shipment itself to the [meat] inspection office under custom-house escort or under customs seal. This conveying is to be attended to by the person having charge of the wares. With regard to these shipments, a transfer book according to Model II [for Model II, see p. 26] is kept by the customs office, in which the [meat] inspection office shall acknowledge the receipt of the shipments and accompanying papers. In these cases the inspector is to be placed under oath for the customs duties, that the customs claims with respect to the meat turned over to the [meat] inspection office may be made secure.

The administrative authorities are authorized to issue more specific provisions with regard to the traffic between the several offices [customs offices] and the [meat] inspection offices, if need be, after agreement with the officials superior to the latter.

Der Fleischbeschau unterliegende Waren bleiben bis zur Beendigung und im Falle des § 15 Abs. 3 bis zum Beginn der Untersuchung unter zollamtlichem Verschluss oder, falls ein solcher nicht durchzuführen ist, mit Genehmigung des Hauptamtsvorstandes unter zollamtlicher Aufsicht.

Die gemäss Abs. 1 vorzunehmenden Revisionen frischen Fleisches erhalten, soweit nicht der § 27 des Vereinszollgesetzes entgegensteht, den Vorrang vor denjenigen anderer, gleichzeitig vorgeführter Waren. Die Revision findet an ordentlicher Amtsstelle statt. Auf Antrag kann von dem Vorstande der Zollstelle genehmigt werden, dass sie an anderen Orten (z. B. an der Beschaustelle) vorgenommen wird. Eine solche Genehmigung ist nur dann zu erteilen, wenn an diesen Orten geeignete Räume zur Verfügung stehen, in denen die Ware bis zur Beendigung der Revision und Untersuchung unter zollamtlichem Verschluss oder, falls der Hauptamtsvorstand dies gemäss dem vorigen Absatze zugelassen hat, unter zollamtlicher Aufsicht gehalten werden kann.

§ 15.

Alsbald nach dem Eintreffen beschaupflichtiger Waren hat die Zollstelle der Beschaustelle hiervon Nachricht zu geben, sofern nicht mit dieser ein für allemal regelmässige Zeiten für die Besichtigung und Probeentnahme (Abs. 2) vereinbart sind.

Die Beschaustelle nimmt—und zwar, soweit möglich, im unmittelbaren Anschluss an die zollamtliche Revision—die vorgeschriebene Besichtigung des Fleisches vor, entnimmt die für die Untersuchung erforderlichen Proben, deren Gewicht zollamtlich festzustellen ist, und erhält die über die Sendung vorhandenen Begleitpapiere. Den Empfang der Proben und der Begleitpapiere hat sie in einem von der Zollstelle nach Muster I geführten Überweisungsbuch anzuerkennen.

Es ist zulässig, die Sendung selbst der Beschaustelle unter zollamtlicher Begleitung oder unter Zollverschluss zuzuführen. Die Zuführung hat der Verfügungsberechtigte zu bewirken. Über diese Sendungen wird von der Zollstelle ein Überweisungsbuch nach Muster II geführt, in welchem die Beschaustelle den Empfang der Sendungen und Begleitpapiere anzuerkennen hat. Für diese Fälle ist der Beschauer zur Sicherung des Zollanspruchs hinsichtlich des der Beschaustelle überwiesenen Fleisches auf das Zollinteresse zu vereidigen.

Die Direktivbehörden sind ermächtigt, nähere Vorschriften über den Verkehr zwischen den einzelnen Amtsstellen und den Beschaustellen, erforderlichenfalls im Einvernehmen mit den den letzteren vorgesetzten Behörden, zu erlassen.

[*Model I for the transfer book.*]

	Transfer of meat samples.													Clearance.						
Serial No.	Of the transfer.		Of the customs register.		Name and place of residence of the—		Of the packages from which samples are taken.			Weight of the samples determined by the customs office (kg.).	Designation and number of the—		Signature of the meat-inspection office certifying reception.	The meat is (a) passed, (b) destroyed, (c) to be reexported.	Of the samples have been—		Designation and number of the returned—		Signature of the official as a certificate of receiving the returned wares (columns 10b and 11).	Remarks.
	Day.	Hour.	Designation.	Number.	Sender.	Addressee.	Number and kind.	Designation.	Content.		Customs papers.	Other accompanying papers.			Used (kg.).	Returned (kg.).	Customs papers.	Other accompanying papers.		
1.	2.		3.		4.		5.			6.	7.		8.	9.	a. 10.	b.	11.		12.	13.

[*Model II for the transfer book.*]

	Transfer.														Clearance.				
Serial No.	Of the transfer.		Of the customs register.		Name and place of residence of the—		Customs office findings with regard to the packages.					Designation and number of the—		Signature of the [meat] inspection office as certificate of receiving.	The meat is (a) passed, (b) disposed of, (c) to be reexported.	The shipment is—		Signature of the official as a certificate of receiving the returned wares (columns 6 and 9b).	Remarks.
	Day.	Hour.	Designation.	Number.	Sender.	Addressee.	Number and kind.	Designation.	Weight.	Content determined.	Sealing or escort.	Customs papers.	Other accompanying papers.			Handed over to the addressee.	Returned to the customs office.		
1.	2.		3.		4		5.					6.		7.	8.	a. 9.	b.	10.	11.

Muster I zum Überweisungsbuche.

Lfd. Nr	Überweisung von Fleischproben.													Erledigung.						Bemerkungen.
	Der Überweisung		Des Zollregisters		Name und Wohnort des		Der Packstücke, aus denen Proben entnommen sind,			Zollamtlich ermitteltes Gewicht der Proben. kg.	Bezeichnung und Stückzahl der		Unterschrift der Beschaustelle als Empfangsbescheinigung.	Das Fleisch ist: a) freigegeben, b) vernichtet, c) wieder auszuführen.	Von den Proben sind		Bezeichnung und Stückzahl der zurückgegebenen		Unterschrift des Beamten als Bescheinigung über den Rückempfang (Spalte 10 b u. 11).	
	Tag.	Stunde.	Bezeichnung.	Nummer.	Absenders.	Empfängers.	Zahl und Art.	Bezeichnung.	Inhalt.		Zollpapiere.	sonstigen Begleitpapiere.			verbraucht. kg.	zurückgegeben. kg.	Zollpapiere.	sonstigen Begleitpapiere.		
1.	2.		3.		4.		5.			6.	7.		8.	9.	a. 10.	b.	11.		12.	13.

Muster II zum Überweisungsbuche.

Lfd. Nr.	Überweisung.														Erledigung.				Bemerkungen.
	Der Überweisung		Des Zollregisters		Name and Wohnort des		Zollamtlicher Befund der Packstücke					Bezeichnung und Stückzahl der		Unterschrift der Beschaustelle als Empfangsbescheinigung.	Das Fleisch ist: a) freigegeben, b) beseitigt, c) wieder auszuführen.	Die Sendung ist		Unterschrift des Beamten als Bescheinigung über den Rückempfang (Spalte 6 u. 9 b).	
	Tag.	Stunde.	Bezeichnung.	Nummer.	Absenders.	Empfängers.	Zahl und Art.	Bezeichnung.	Gewicht.	ermittelter Inhalt.	Verschluss oder Begleitung.	Zollpapiere.	sonstigen Begleitpapiere.			dem Empfänger ausgehändigt.	der Zollstelle zurückgegeben.		
1.	2.		3.		4.		5.					6.		7.	8.	a. 9.	b.	10.	11.

§ 16.

The customs office receives, in addition to the information considered in §§ 24 and 30 of the regulations D concerning the carrying out of the law, from the [meat] inspection office on the return of the accompanying papers, a written report as to the final result of the inspection, which is to be stamped upon the customs papers at hand concerning the shipment, or is to be filed as a voucher in the customs registers. In the report also the number of samples used for the purposes of the inspection is to be stated. Upon the basis of the report and of the establishing of the weight prescribed in the following paragraph, the customs office shall fill out in the transfer book the clearance columns [9–12] concerning the disposal of the wares.

The samples taken, not used for the purposes of the inspection, are to be returned to the customs office. So far as [in case] they have, by the examination, been made unfit for use, they are to be destroyed under customs surveillance; otherwise, after the establishing of their weight they are to be placed back with the shipment. The services necessary for this purpose are to be rendered by the person who has charge of the shipment.

If the entire shipment has been brought to the [meat] inspection office (§ 15, paragraph 3), the person having charge of the wares shall take it back again to the customs office, so far as [in case] clearance outside of the regular office is not granted or so far as [in case] the shipment is to be destroyed upon the order of the police authorities. The returning to the customs office shall take place under custom-house escort or under customs seal.

§ 17.

If the examination does not occur at the frontier office the meat is to be turned over to the office (at whose place the inspection is to occur) under customs seal, and in so far as possible under seal in a compartment, or under custom-house escort with Permit [Begleitschein] I, or permit-slip [Begleitzettel].

The permits [Begleitscheine], or permit-slips [Begleitzettel], made out for such meat shipments receive on the upper border of the first page the note "meat inspection," to be made with a colored pencil or by means of a stamp. In the registers kept of these permits [Begleitscheine], or permit-slips [Begleitzettel], the same note is to be made in a suitable place.

After the arrival of the meat shipments at the place where the inspection is to be made, a procedure is to be carried out in accordance with that mentioned in §§ 14 to 16. The inspection [revision] by the customs office (§ 14, paragraph 1) is, however, to be extended at least so far that the decision may be made as to whether the person transporting the wares has fulfilled his obligations in accordance with the permit [Begleitschein], or permit-slip [Begleitzettel].

§ 16.

Die Zollstelle erhält, abgesehen von den in den §§ 24 und 30 der Ausführungsbestimmungen D vorgesehenen Mitteilungen, von der Beschaustelle bei Rückgabe der Begleitpapiere eine schriftliche Benachrichtigung über das endgültige Ergebnis der Untersuchung, welche den über die Sendung vorhandenen Zollpapieren anzustempeln oder als Beleg zu den Zollregistern zu nehmen ist. In der Benachrichtigung ist auch die Menge der für die Zwecke der Untersuchung verbrauchten Proben anzugeben. Auf Grund der Benachrichtigung und der im folgenden Absatze vorgeschriebenen Gewichtsfeststellung hat die Zollstelle die Erledigungsspalten des Überweisungsbuchs auszufüllen.

Die entnommenen, für die Zwecke der Untersuchung nicht verbrauchten Proben sind der Zollstelle wieder auszuhändigen. Sie sind, sofern sie durch die Untersuchung unbrauchbar geworden sind, unter zollamtlicher Aufsicht zu vernichten, anderenfalls nach Feststellung ihres Gewichts der Sendung wieder beizufügen. Die hierzu erforderlichen Hülfsdienste sind von demjenigen zu leisten, welcher das Verfügungsrecht über die Sendung hat.

Ist der Beschaustelle die ganze Sendung zugeführt worden (§ 15 Abs. 3), so hat sie der Verfügungsberechtigte wieder zur Zollstelle zurückzuführen, sofern nicht die Abfertigung ausserhalb der ordentlichen Amtsstelle genehmigt oder die Sendung auf Anordnung der Polizeibehörde zu vernichten ist. Die Zurückführung zur Zollstelle hat unter zollamtlicher Begleitung oder unter Zollverschluss zu erfolgen.

§ 17.

Findet die Untersuchung nicht beim Eingangsamte statt, so ist das Fleisch an das Amt, an dessen Sitz die Untersuchung vorgenommen werden soll, unter zollamtlichem Verschluss, und zwar nach Möglichkeit unter Raumverschluss, oder unter zollamtlicher Begleitung mit Begleitschein I oder Begleitzettel zu überweisen.

Die über derartige Fleischsendungen ausgestellten Begleitscheine oder Begleitzettel erhalten am oberen Rande der ersten Seite den mit Buntstift oder durch Stempelabdruck zu bewirkenden Vermerk: "Fleischbeschau." In die über diese Begleitscheine oder Begleitzettel geführten Register ist an geeigneter Stelle derselbe Vermerk aufzunehmen.

Nach Ankunft der Fleischsendungen an dem Orte, an welchem die Untersuchungen vorzunehmen ist, findet das in den §§ 14 bis 16 bezeichnete Verfahren entsprechende Anwendung. Die zollamtliche Revision (§ 14 Abs. 1) ist jedoch mindestens soweit auszudehnen, dass beurteilt werden kann, ob der Warenführer seinen Verpflichtungen aus dem Begleitschein oder Begleitzettel nachgekommen ist.

§ 18.

After the termination of the inspection and marking of the meat the office at whose place the inspection has occurred shall undertake the further customs clearance.

Meat passed upon the ground of the inspection can finally be placed in free traffic, sent with Permit I or II, or shipped to a public or to a private warehouse.

The administrative authorities are authorized, in case of necessity, to grant that for meat which is reported for shipment to a public or private warehouse the inspection in whole or in part be postponed until the time of notification of taking the wares out of storage. Permission is to be given only when at the place of the warehouse there is also an inspection office.

§ 19.

If the reexportation of the meat rejected from importation is required by the police authorities, it shall take place under customs seal or custom-house escort. The same obtains for meat voluntarily withdrawn. Meat rejected or voluntarily withdrawn shall be designated as such in the accompanying papers.

§ 20.

When, by order of the police authorities (§ 28 of the regulations D, concerning the carrying out of the law), condemned meat is to be disposed of in such a manner that it can do no harm, a customs or revenue official shall be present if the customs on the meat are to be remitted or reduced because of such disposal. This official shall present to the office a written notice with regard to the manner of disposal of the meat, which [notice] becomes a voucher for the customs registers. The police authorities shall give ample notification to the customs office as to the place and time of such disposal of the meat.

According to specific regulations of the administrative authorities in special cases the cooperative surveillance of such disposal of condemned meat by a customs or revenue official may be omitted. In such a case the police authorities after the accomplishment of such disposal of the meat shall make out a written certificate for the customs office as a voucher for the customs registers.

If the packing material is not burned or otherwise harmlessly disposed of, but has been disinfected (§ 28, paragraph 4, of the regulations D, concerning the carrying out of the law), either duty is to be paid on it according to its nature or it is to be reexported past the customs line.

§ 18.

Nach Beendigung der Untersuchung und Kennzeichnung des Fleisches hat das Amt, an dessen Sitz die Untersuchung erfolgt ist, die weitere zollamtliche Abfertigung vorzunehmen.

Das auf Grund der Untersuchung freigegebene Fleisch kann nunmehr in den freien Verkehr gesetzt, auf Begleitschein I oder II versandt oder zur öffentlichen Niederlage oder zu einem Privatlager abgefertigt werden.

Die Direktivbehörden sind ermächtigt im Bedürfnissfalle zu gestatten, dass für Fleisch, welches zur öffentlichen Niederlage oder zu einem Privatlager abgefertigt werden soll, die Untersuchung ganz oder teilweise bis zu dem Zeitpunkte der Abmeldung von der Niederlage ausgesetzt bleibt. Die Genehmigung ist nur zu erteilen, wenn sich am Orte der Niederlage auch eine Untersuchungsstelle befindet.

§ 19.

Wird die Wiederausfuhr des von der Einfuhr zurückgewiesenen Fleisches von der Polizeibehörde veranlasst, so hat sie unter Zollverschluss oder zollamtlicher Begleitung zu erfolgen. Dasselbe gilt für freiwillig zurückgezogenes Fleisch. Das zurückgewiesene oder freiwillig zurückgezogene Fleisch ist in dem Begleitpapier als solches zu bezeichnen.

§ 20.

Der unschädlichen Beseitigung beanstandeten Fleisches, welche von der Polizeibehörde veranlasst wird (§ 28 der Ausführungsbestimmungen D), hat ein Zoll- oder Steuerbeamter beizuwohnen, sofern dadurch die Zollfreiheit des Fleisches oder eine Zollermässigung herbeigeführt werden soll. Dieser hat über die Art der Beseitigung des Fleisches eine schriftliche Anzeige, welche Belag für die Zollregister wird, der Amtsstelle vorzulegen. Die Polizeibehörde hat der Zollstelle über Ort und Zeit der unschädlichen Beseitigung rechtzeitig Mitteilung zu machen.

Nach näherer Bestimmung der Direktivbehörde kann in besonderen Fällen von der Mitüberwachung der unschädlichen Beseitigung beanstandeten Fleisches durch einen Zoll- oder Steuerbeamten abgesehen werden. Solchenfalls hat die Polizeibehörde nach Ausführung der unschädlichen Beseitigung des Fleisches eine schriftliche Bescheinigung hierüber der Zollstelle als Belag für die Zollregister mitzuteilen.

Ist das Verpackungsmaterial nicht verbrannt oder anderweit unschädlich beseitigt, sondern desinfiziert worden (§ 28 Abs. 4 der Ausführungsbestimmungen D), so ist es entweder nach Massgabe seiner Beschaffenheit zu verzollen oder in das Ausland wieder auszuführen.

§ 21.

To meat which is not intended for food for man, and which according to § 29 of the regulations D, concerning the carrying out of the law is admitted for importation by the police authorities without previous inspection, after proof has been established that it has been made useless as food for man in the prescribed manner, §§ 13 to 20 do not apply; on the contrary, in such cases the usual prescribed dispatching procedure obtains.

The latter obtains also in the case of § 22 of the regulations D, concerning the carrying out of the law.

In making the material unfit for use, § 20 has its corresponding application.

§ 22.

In establishing the quantity of the inspected meat to be treated as subject to customs and the amount of customs to be paid, the process shall be according to the following principles:

(a) For meat which is disposed of in such a manner that it can do no harm (§ 20) and in the process is destroyed, customs is not collected. The same obtains for the samples taken, so far as they have been used for the purposes of inspection or have thereby become unfit for use.

(b) In how far customs are to be collected in the case of § 21, or in case of harmless disposal which does not lead to a destruction of the wares, is to be decided according to the customs law [Vereinszollgesetz], the table of duties and the regulations issued concerning these.

(c) Whether duties are to be collected for wares rejected from importation or voluntarily withdrawn—inclusive of the samples returned to the customs authorities (§ 16, paragraph 2)—is regulated according to the provisions of the customs law [Vereinszollgesetz] and of the permit regulations.

§ 23.

If, in case the wares are intended for shipment in direct transit (§ 11, No. 2), this intention is afterwards changed, then—without prejudice to any punitive proceedings to be undertaken according to § 27, No. 4, of the law—the meat inspection shall immediately follow. The same obtains for such shipments as are imported through unauthorized frontier places otherwise than by post and which are not recognized to be subject to meat inspection until they have reached their place of destination. In both cases the provisions of §§ 13 to 22 have their corresponding application.

§ 24.

Postal shipments with content subject to [meat] inspection are to be marked by the post-office authorities with the designation "Fleisch-

§ 21.

Auf Fleisch, welches nicht für den menschlichen Genuss bestimmt ist und seitens der Polizeibehörde nach § 29 der Ausführungsbestimmungen D ohne vorherige Untersuchung zur Einfuhr zugelassen wird, nachdem seine Unbrauchbarmachung für den menschlichen Genuss in der vorgeschriebenen Weise sichergestellt ist, finden die §§ 13 bis 20 keine Anwendung, vielmehr bewendet es in solchen Fällen bei dem allgemein vorgeschriebenen Abfertigungsverfahren.

Letzteres gilt auch im Falle des § 22 der Ausführungsbestimmungen D.

Auf die Unbrauchbarmachung findet § 20 entsprechende Anwendung.

§ 22.

Bei der Festsetzung der als zollpflichtig zu behandelnden Menge des untersuchten Fleisches und des zu entrichtenden Zollbetrags ist nach folgenden Grundsätzen zu verfahren:

a) Für Fleisch, welches unschädlich beseitigt (§ 20) und dabei vernichtet worden ist, kommt Zoll nicht zur Erhebung. Das gleiche gilt für die entnommenen Proben, soweit sie für die Zwecke der Untersuchung verbraucht worden oder dadurch unbrauchbar geworden sind.

b) Inwieweit im Falle des § 21 oder bei der unschädlichen Beseitigung, die nicht zu einer Vernichtung der Ware führt, Zollerhebung eintritt, ist nach dem Vereinszollgesetze, dem Zolltarif und den dazu ergangenen Bestimmungen zu beurteilen.

c) Ob für die von der Einfuhr zurückgewiesenen oder freiwillig zurückgezogenen Waren—einschliesslich der an die Zollbehörde zurückgelangten Proben (§ 16 Abs. 2)—Zoll zu erheben ist, regelt sich nach den Vorschriften des Vereinszollgesetzes und des Begleitscheinregulativs.

§ 23.

Wird im Falle der Bestimmung der Ware zur unmittelbaren Durchfuhr (§ 11 Ziffer 2) diese Bestimmung nachträglich geändert, so ist—unbeschadet des nach § 27 Ziffer 4 des Gesetzes etwa einzuleitenden Strafverfahrens—die Fleischbeschau alsbald nachzuholen. Dasselbe gilt für solche Sendungen, die über nicht zugelassene Grenzstellen in anderer Weise als mit der Post eingeführt und erst am Bestimmungsort als fleischbeschaupflichtig erkannt werden. In beiden Fällen sind die Vorschriften der §§ 13 bis 22 entsprechend anzuwenden.

§ 24.

Postsendungen mit beschaupflichtigem Inhalte sind von der Postbehörde durch die Bezeichnung "Fleischbeschau" kenntlich zu machen

beschau" ["Meat inspection"] and to be taken to a customs or revenue office at whose place is found a [meat] inspection office competent for the examination. This also obtains when, in the case of a shipment whose content has not been recognized from the beginning as subject to [meat] inspection, at the final clearance such content is found and at the place of the office there is not present an authorized place for the examination. The final clearance, in this case, is to be left to the office at whose place the examination is made, and the postal parcel to be returned to and receipted for by the post-office authorities. Upon the application of the addressee further shipment may be suspended and the wares subject to inspection be destroyed under customs surveillance.

The provisions of § 16 of the postal-duties regulations are not influenced by the above regulations.

§ 25.

§§ 13 to 22 apply to postal trade (§ 24), with the provision that in the case of shipping post packages subject to [meat] inspection to the place of [meat] inspection, as well as of post packages whose content, upon the ground of examination, is rejected from importation or voluntarily withdrawn, the making out of permits, and the placing of a customs seal or custom-house escort is not necessary.

§ 26.

Meat which in accordance with the regulation concerning the treatment by the customs office of wares reimported through a region outside the customs line to a point within the customs line is shipped to a point outside the customs line is to be sent under customs seal or under custom-house escort.

At the office of reimportation the final clearance shall always take place according to § 11 of the regulation mentioned. If no suspicion arises with respect to the identity of the wares presented with the exported wares, §§ 9, paragraph 1, and 13 to 25 do not apply.

§ 27.

In all other respects for the importation of meat the regulations of the customs law [Vereinszollgesetz] and of the provisions issued with regard to the carrying out of the regulations apply.

§ 28.

The specific regulations with regard to the measures to be taken by customs authorities for the entrance and inspection places situated outside the customs line shall be issued by the [separate] federated governments concerned.

und einem Zoll- oder Steueramte zuzuführen, an dessen Sitze sich eine für die Untersuchung zuständige Beschaustelle befindet. Dies gilt auch dann, wenn bei einer Sendung, deren Inhalt als beschaupflichtig nicht von Anfang an erkannt worden ist, bei der Schlussabfertigung ein solcher Inhalt vorgefunden wird und am Sitze des Amtes eine zur Untersuchung befugte Stelle nicht vorhanden ist. Die Schlussabfertigung ist in diesem Falle dem Amte, an dessen Sitze die Untersuchung stattfindet, zu überlassen und das Poststück der Postbehörde gegen Quittung zurückzugeben. Auf Antrag des Empfängers kann von der Weitersendung abgesehen und die beschaupflichtige Ware unter zollamtlicher Aufsicht vernichtet werden.

Die Vorschriften des § 16 des Postzollregulativs werden durch vorstehende Bestimmungen nicht berührt.

§ 25.

Die §§ 13 bis 22 finden auf den Postverkehr (§ 24) mit der Massgabe Anwendung, dass bei der Versendung von beschaupflichtigen Poststücken zur Beschaustelle, sowie von Poststücken, deren Inhalt auf Grund der Untersuchung von der Einfuhr zurückgewiesen oder freiwillig zurückgezogen wird, die Ausstellung von Begleitscheinen und die Anlegung eines Zollverschlusses oder zollamtliche Begleitung nicht erforderlich ist.

§ 26.

Fleisch, welches auf Grund des Regulativs, die zollamtliche Behandlung von Warensendungen aus dem Inlande durch das Ausland nach dem Inlande betreffend, zur Versendung in das Ausland abgefertigt wird, ist unter zollamtlichem Verschluss oder unter zollamtlicher Begleitung abzulassen.

Beim Wiedereingangsamte hat stets die Schlussabfertigung gemäss § 11 des bezeichneten Regulativs einzutreten. Ergeben sich hierbei keine Bedenken hinsichtlich der Identität der vorgeführten mit den ausgeführten Waren, so finden die §§ 9 Absatz 1 und 13 bis 25 keine Anwendung.

§ 27.

Im übrigen finden auf die Einfuhr von Fleisch die Bestimmungen des Vereinszollgesetzes und der dazu erlassenen Ausführungsvorschriften Anwendung.

§ 28.

Die näheren Vorschriften über das Verfahren der Zollbehörden bei den im Auslande gelegenen Einlass- und Untersuchungsstellen werden von den beteiligten Landesregierungen erlassen.

Proclamation.

Concerning the marking of inspected foreign meat, of February 10, 1903.

In accordance with § 26, paragraph 3, of the regulations D concerning the carrying out of the law with regard to the inspection of food animals and of meat, of June 3, 1900 (appendix to No. 22 of the Centralblatt für das Deutsche Reich, Jahrgang 1902, p. 39*), the following regulations are made for the marking of inspected foreign meat:

1. The stamps made use of must present exactly the shape and size given in § 26, paragraph 4, of the regulations D concerning the carrying out of the law—without prejudice to the exceptions allowed in paragraph 5 in the place cited.

2. The inscriptions shall be made in Latin letters and of such a size as to be easily legible.

The letters and the margins must be sharply defined.

3. The inscriptions are without exception to be placed upon straight lines.

4. Every stamp shall be provided with the inscription "Ausland" ["Foreign"] on the uppermost line. In the case of meat found fit, there follows upon another line the symbol of the customs or revenue office at which the inspection is undertaken. As such a symbol, only the name of the inspection office given in column 2 of the following list or the abbreviation added in parentheses is to be used. The addition of the official designation of the inspection office shall be omitted.

5. In the case of stamps for meat of horses or other solipeds, immediately after the word "Ausland" ["Foreign"], upon a special line the word "Pferd" ["Horse"] is inserted.

6. Upon a line preceding the symbol of the customs or revenue office the stamps for condemned meat shall be provided with the [following] inscriptions:

"Zurückgewiesen" ["Rejected"], in the case of rejected meat;

"Zu beseitigen" ["To be disposed of"], in the case of meat to be disposed of in such a manner that it can do no harm;

"Z," in the case of voluntarily withdrawn meat.

7. The placing of other names, designations, or symbols (for example, coat of arms) is to be avoided. An exception is made for the use of Latin or Arabic numerals as differentiating signs for the use of officials inside the office.

8. In case that for several customs or revenue offices a common [meat] inspection office is established, the decision as to the stamp is reserved.

COUNT V. POSADOWSKY,
Deputy Imperial Chancellor.

BERLIN, *February 10, 1903.*

Bekanntmachung,

betreffend die Kennzeichnung des untersuchten ausländischen Fleisches. Vom 10. Februar 1903.

Auf Grund des § 26 Abs. 3 der Ausführungsbestimmungen D zum Schlachtvieh- und Fleischbeschaugesetze vom 3. Juni 1900 (Beilage zu Nr. 22 des Centralblattes für das Deutsche Reich, Jahrgang 1902, Seite 39*) wird für die Kennzeichnung des untersuchten ausländischen Fleisches folgendes bestimmt:

1. Die zur Verwendung gelangenden Stempel müssen genau die im § 26 Abs. 4 der Ausführungsbestimmungen D angegebenen Formen und Grössenverhältnisse—unbeschadet der im Abs. 5 a. a. O. zugelassenen Ausnahmen—aufweisen.

2. Die Inschriften sind mit lateinischen Schriftzeichen herzustellen und in solcher Grösse anzufertigen, dass sie gut leserlich sind.

Die Schriftzeichen und die Ränder müssen scharf ausgeprägt sein.

3. Die Inschriften sind ausnahmslos auf geraden Linien anzubringen.

4. Jeder Stempel hat auf der obersten Zeile die Inschrift "Ausland" zu enthalten. Bei tauglich befundenem Fleische folgt auf neuer Zeile das Zeichen der Zoll- oder Steuerstelle, bei welcher die Untersuchung vorgenommen ist. Als solches Zeichen ist ausschliesslich der in Spalte 2 des nachstehenden Verzeichnisses angegebene Name der Untersuchungsstelle oder die in Klammern beigefügte Kürzung anzuwenden. Die Beifügung der Amtsbezeichnung der Untersuchungsstelle hat zu unterbleiben.

5. Bei den Stempeln für Fleisch von Pferden oder anderen Einhufern wird unmittelbar nach dem Worte "Ausland" auf einer besonderen Zeile das Wort "Pferd" eingeschoben.

6. Die Stempel für beanstandetes Fleisch enthalten auf einer dem Zeichen der Zoll- oder Steuerstelle vorangehenden Zeile die Inschrift
"Zurückgewiesen" bei zurückgewiesenem Fleische,
"Zu beseitigen" bei unschädlich zu beseitigendem Fleische,
"Z" bei freiwillig zurückgezogenem Fleische.

7. Die Anbringung sonstiger Namen, Bezeichnungen oder Zeichen (z. B. Wappen) ist zu vermeiden. Ausgenommen ist die Verwendung von lateinischen oder arabischen Ziffern als Unterscheidungsmerkmale für den inneren dienstlichen Verkehr.

8. Für den Fall, dass für mehrere Zoll- oder Steuerstellen eine gemeinsame Beschaustelle errichtet ist, bleibt die Bestimmung des Stempelzeichens vorbehalten.

BERLIN, *den 10. Februar 1903.*

DER STELLVERTRETER DES REICHSKANZLERS.
GRAF V. POSADOWSKY.

List of the inspection offices for foreign meat.

Designation of the inspection office.	Symbol of the inspection office.
Aachen, head customs office	Aachen.
Altkirch, head customs office	Altkirch.
Altmünsterol, branch customs office I	Altmünsterol (Altmünstl.).
Altona, head customs office	Altona.
Augsburg, head customs office	Augsburg (Augsbg.).
Avricourt s. Deutsch-, branch customs office I	Avricourt (Avric.)
Baden, head revenue office	Baden.
Basel (Baden), customs office at the Baden railway office	Basel B.
Basel (Alsace-Lorraine), branch customs office I	Basel E.
Bentheim, branch customs office I	Bentheim.
Berlin, head revenue office for foreign articles	Berlin.
Beuthen, Upper Silesia clearance office	Beuthen.
Bielefeld, revenue office I at the railway station	Bielefeld (Bielefd.).
Bocholt, branch customs office I	Bocholt.
Bodenbach, branch customs office I	Bodenbach (Bodenbch.).
Borken, branch customs office I	Borken.
Brake, head customs office	Brake.
Braunschweig, head revenue office	Braunschweig (Braunschw.).
Bremen, head customs office	Bremen.
Bremerhaven, head customs office	Bremerhaven (Bremerhn.).
Breslau, head revenue office I	Breslau.
Bromberg, head revenue office	Bromberg (Brombg.).
Chemnitz, head customs office	Chemnitz (Chemn.).
Cleve, head customs office	Cleve.
Cologne, head revenue office for foreign articles	Cologne.
Crefeld, head revenue office	Crefeld (Crefd.).
Dalheim, branch customs office I	Dalheim.
Danzig, head customs office	Danzig.
Darmstadt, head revenue office	Darmstadt (Darmst.).
Dessau, head revenue office	Dessau.
Deutsch-Avricourt, branch customs office I	Avricourt (Avric.).
Diedenhofen, head customs office	Diedenhofen (Diedenh.).
Dortmund, head revenue office	Dortmund (Dortmd.).
Dresden, head customs office I	Dresden.
Düren, head revenue office	Düren.
Düsseldorf, head revenue office	Düsseldorf (Düsseldf.).
Duisburg, head revenue office	Duisburg (Duisbg.).
Eger, branch customs office I	Eger.
Elberfeld, head revenue office	Elberfeld (Elberfd.).
Elten, branch customs office I	Elten.
Emden, head customs office	Emden.
Emmerich, head customs office	Emmerich (Emmer.).
Erfurt, head revenue office	Erfurt.
Essen, revenue office I at the Cologne-Mindener railway station.	Essen.
Eydtkuhnen, head customs office	Eydtkuhnen (Eydtk.).
Fentsch, branch customs office I	Fentsch.
Flensburg, head customs office	Flensburg (Flensbg.).
Frankfort on the Main, head revenue office	Frankfort on the Main (Frankf.).
Freiburg, head revenue office	Freiburg (Freibg.).
Friedrichshafen, head customs office	Friedrichshafen (Friedrhn.).
Fürth, head customs office	Fürth.
Furth on the Weser, head customs office	Furth a. W. (Furth W.).
Geestemünde, head customs office	Geestemünde (Geestem).
Gera, head revenue office	Gera.
Glauchau, revenue office	Glauchau.
Glogau, head revenue office	Glogau.

Verzeichnis der Untersuchungsstellen für ausländisches Fleisch.

Bezeichnung der Untersuchungsstelle. 1.	Zeichen der Untersuchungsstelle. 2.
Aachen, Hauptzollamt	Aachen.
Altkirch, Hauptzollamt	Altkirch.
Altmünsterol, Nebenzollamt I	Altmünsterol (Altmünstl.).
Altona, Hauptzollamt	Altona.
Augsburg, Hauptzollamt	Augsburg (Augsbg.).
Avricourt s. Deutsch-, Nebenzollamt I	Avricourt (Avric.).
Baden, Hauptsteueramt	Baden.
Basel (Baden), Zollamt am badischen Bahnhofe	Basel B.
Basel (Els.-Lothr.), Nebenzollamt I	Basel E.
Bentheim, Nebenzollamt I	Bentheim.
Berlin, Hauptsteueramt für ausländische Gegenstände.	Berlin.
Beuthen O. Schl., Zollabfertigungsstelle	Beuthen.
Bielefeld, Steueramt I am Bahnhofe	Bielefeld (Bielefd.).
Bocholt, Nebenzollamt I	Bocholt.
Bodenbach, Nebenzollamt I	Bodenbach (Bodenbch.).
Borken, Nebenzollamt I	Borken.
Brake, Hauptzollamt	Brake.
Braunschweig, Hauptsteueramt	Braunschweig (Braunschw.).
Bremen, Hauptzollamt	Bremen.
Bremerhaven, Hauptzollamt	Bremerhaven (Bremerhn.).
Breslau, Hauptsteueramt I	Breslau.
Bromberg, Hauptsteueramt	Bromberg (Brombg.).
Chemnitz, Hauptzollamt	Chemnitz (Chemn.).
Cleve, Hauptzollamt	Cleve.
Cöln, Hauptsteueramt für ausländische Gegenstände.	Cöln.
Crefeld, Hauptsteueramt	Crefeld (Crefd.).
Dalheim, Nebenzollamt I	Dalheim.
Danzig, Hauptzollamt	Danzig.
Darmstadt, Hauptsteueramt	Darmstadt (Darmst.).
Dessau, Hauptsteueramt	Dessau.
Deutsch-Avricourt, Nebenzollamt I	Avricourt (Avric.).
Diedenhofen, Hauptzollamt	Diedenhofen (Diedenh.).
Dortmund, Hauptsteueramt	Dortmund (Dortmd.).
Dresden, Hauptzollamt I	Dresden.
Düren, Hauptsteueramt	Düren.
Düsseldorf, Hauptsteueramt	Düsseldorf (Düsseldf.).
Duisburg, Hauptsteueramt	Duisburg (Duisbg.).
Eger, Nebenzollamt I	Eger.
Elberfeld, Hauptsteueramt	Elberfeld (Elberfd.).
Elten, Nebenzollamt I	Elten.
Emden, Hauptzollamt	Emden.
Emmerich, Hauptzollamt	Emmerich (Emmer.)
Erfurt, Hauptsteueramt	Erfurt.
Essen, Steueramt I am Cöln-Mindener Bahnhofe	Essen.
Eydtkuhnen, Hauptzollamt	Eydtkuhnen (Eydtk.).
Fentsch, Nebenzollamt I	Fentsch.
Flensburg, Hauptzollamt	Flensburg (Flensbg.)
Frankfurt a. M., Hauptsteueramt	Frankfurt a. M. (Frankf.)
Freiburg, Hauptsteueramt	Freiburg (Freibg.).
Friedrichshafen, Hauptzollamt	Friedrichshafen (Friedrhn.).
Fürth, Hauptzollamt	Fürth.
Furth a. W., Hauptzollamt	Furth a. W. (Furth W.)
Geestemünde, Hauptzollamt	Geestemünde (Geestem.).
Gera, Hauptsteueramt	Gera.
Glauchau, Steueramt	Glauchau.
Glogau, Hauptsteueramt	Glogau.

List of the inspection offices for foreign meat—Continued.

Designation of the inspection office.	Symbol of the inspection office.
Goch, branch customs office I	Goch.
Greiz, revenue office	Greiz.
Halle on the Saal, head revenue office	Halle a. S. (Halle S.).
Hamburg, Entenwärder, head customs office	Hamburg E. (Hambg.).
Hamburg, Erikus, head customs office	Hamburg Er. (Hambg. Er.).
Hamburg, Jonas, head customs office	Hamburg J. (Hambg. J.).
Hamburg, Kehrwieder, head customs office	Hamburg K. (Hambg. K.).
Hamburg, Meyerstrasse, head customs office	Hamburg M. (Hambg. M.).
Hamburg, St. Annen, head customs office	Hamburg A. (Hambg. A.).
Heidelberg, head revenue office	Heidelberg (Heidelbg.).
Heilbronn, head customs office	Heilbronn (Heilbr.).
Hof, head customs office	Hof.
Horbach, branch customs office II	Horbach.
St. Johann-Saarbrücken, head revenue office	Saarbrücken (Saarbr.).
Kaiserslautern, head customs office	Kaiserslautern (Kaisersl.).
Kaldenkirchen, head customs office	Kaldenkirchen (Kaldenk.).
Karlsruhe, head revenue office	Karlsruhe (Karlsr.).
Kattowitz, branch customs office I	Kattowitz (Kattow.).
Kiel, head customs office	Kiel.
Königsberg, head revenue office	Königsberg (Königsbg.).
Konstanz, head revenue office	Konstanz.
Kufstein, branch customs office I	Kufstein.
Lahr, head revenue office	Lahr.
Landau in Pfalz, head customs office	Landau i. Pfalz (Landau).
Landshut, head customs office	Landshut.
Leipzig, head customs office I	Leipzig.
Lindau, head customs office	Lindau.
Lippstadt, head revenue office	Lippstadt (Lippstdt.).
Lörrach, head revenue office	Lörrach.
Ludwigshafen on the Rhine, head customs office	Ludwigshafen a. Rh. (Ludwigshn.).
Lübeck, head customs office	Lübeck.
Magdeburg, head revenue office I	Magdeburg (Magdebg.).
Mayence, head revenue office	Mainz.
Mannheim, head customs office	Mannheim (Mannh.)
Memel, head customs office	Memel.
Metz, head customs office	Metz.
Mülhausen, head revenue office	Mülhausen (Mülhsn.)
Munich I, head customs office	München I.
Munich II, head customs office	München II.
Münster, head revenue office	Münster.
Myslowitz, head customs office	Myslowitz (Myslow.).
Neumünster, revenue office I	Neumünster (Neumünst.).
Novéant, branch customs office I	Novéant.
Nuremberg, head customs office	Nürnberg (Nürnbg.).
Oderberg, Austria, branch customs office I	Oderberg, Österr. (Oderbg.).
Offenbach, head revenue office	Offenbach (Offenbch.).
Oldenburg, head revenue office	Oldenburg (Oldenbg.).
Passau, head customs office	Passau.
Plauen in Vogtland, head customs office	Plauen i. V. (Plauen).
Posen, head revenue office	Posen.
Regensburg, head customs office	Regensburg (Regensbg.).
Rendsburg, revenue office I	Rendsburg (Rendsbg.).
Riesa, clearance office at the port	Riesa.
Rosenheim, head customs office	Rosenheim (Rosenh.).
Rostock, head customs office	Rostock.
Ruhrort, revenue office I	Ruhrort.
Saarbrücken (St. Johann-), head revenue office	Saarbrücken (Saarbr.).
Säckingen, head revenue office	Säckingen (Säcking.).
St. Johann-Saarbrücken, head revenue office	Saarbrücken (Saarbr.).

Verzeichnis der Untersuchungsstellen für ausländisches Fleisch—Fortsetzung folgt.

Bezeichnung der Untersuchungsstelle. 1.	Zeichen der Untersuchungsstelle. 2.
Goch, Nebenzollamt I	Goch.
Greiz, Steueramt	Greiz.
Halle a. S., Hauptsteueramt	Halle a. S. (Halle S.).
Hamburg, Entenwärder, Hauptzollamt	Hamburg E. (Hambg.).
Hamburg, Erikus, Hauptzollamt	Hamburg Er. (Hambg. Er.).
Hamburg, Jonas, Hauptzollamt	Hamburg J. (Hambg. J.).
Hamburg, Kehrwieder, Hauptzollamt	Hamburg K. (Hambg. K.).
Hamburg, Meyerstrasse, Hauptzollamt	Hamburg M. (Hambg. M.).
Hamburg, St. Annen, Hauptzollamt	Hamburg A. (Hambg. A.).
Heidelberg, Hauptsteueramt	Heidelberg (Heidelbg.).
Heilbronn, Hauptzollamt	Heilbronn (Heilbr.).
Hof, Hauptzollamt	Hof.
Horbach, Nebenzollamt II	Horbach.
St. Johann-Saarbrücken, Hauptsteueramt	Saarbrücken (Saarbr.).
Kaiserslautern, Hauptzollamt	Kaiserslautern (Kaisersl.).
Kaldenkirchen, Hauptzollamt	Kaldenkirchen (Kaldenk.).
Karlsruhe, Hauptsteueramt	Karlsruhe (Karlsr.).
Kattowitz, Nebenzollamt I	Kattowitz (Kattow.).
Kiel, Hauptzollamt	Kiel.
Königsberg, Hauptsteueramt	Königsberg (Königsbg.).
Konstanz, Hauptsteueramt	Konstanz.
Kufstein, Nebenzollamt I	Kufstein.
Lahr, Hauptsteueramt	Lahr.
Landau i. Pfalz, Hauptzollamt	Landau i. Pfalz (Landau).
Landshut, Hauptzollamt	Landshut.
Leipzig, Hauptzollamt I	Leipzig.
Lindau, Hauptzollamt	Lindau.
Lippstadt, Hauptsteueramt	Lippstadt (Lippstdt.).
Lörrach, Hauptsteueramt	Lörrach.
Ludwigshafen a. Rh., Hauptzollamt	Ludwigshafen a. Rh. (Ludwigshn.).
Lubeck, Hauptzollamt	Lübeck.
Magdeburg, Hauptsteueramt I	Magdeburg (Magdebg.).
Mainz, Hauptsteueramt	Mainz.
Mannheim, Hauptzollamt	Mannheim (Mannh.).
Memel, Hauptzollamt	Memel.
Metz, Hauptzollamt	Metz.
Mülhausen, Hauptsteueramt	Mülhausen (Mülhsn.).
München I, Hauptzollamt	München I.
München II, Hauptzollamt	München II.
Münster, Hauptsteueramt	Münster.
Myslowitz, Hauptzollamt	Myslowitz (Myslow.).
Neumünster, Steueramt I	Neumünster (Neumünst.).
Novéant, Nebenzollamt I	Novéant.
Nürnberg, Hauptzollamt	Nürnberg (Nürnbg.).
Oderberg, Österr.-, Nebenzollamt I	Oderberg, Österr. (Oderbg.).
Offenbach, Hauptsteueramt	Offenbach (Offenbch.).
Oldenburg, Hauptsteueramt	Oldenburg (Oldenbg.).
Passau. Hauptzollamt	Passau.
Plauen i. V., Hauptzollamt	Plauen i. V. (Plauen).
Posen, Hauptsteueramt	Posen.
Regensburg, Hauptzollamt	Regensburg (Regensbg.).
Rendsburg, Steueramt I	Rendsburg (Rendsbg.).
Riesa, Zollabfertigungsstelle am Hafen	Riesa.
Rosenheim, Hauptzollamt	Rosenheim (Rosenh.).
Rostock, Hauptzollamt	Rostock.
Ruhrort, Steueramt I	Ruhrort.
Saarbrücken (St. Johann-), Hauptsteueramt	Saarbrücken (Saarbr.).
Säckingen, Hauptsteueramt	Säckingen (Säcking.).
St. Johann-Saarbrücken, Hauptsteueramt	Saarbrücken (Saarbr.).

List of the inspection offices for foreign meat—Continued.

Designation of the inspection office.	Symbol of the inspection office.
Salzburg, branch customs office I	Salzburg (Salzbg.).
Simbach, head customs office	Simbach.
Singen, head revenue office	Singen.
Stettin, head revenue office I	Stettin.
Stralsund, head customs office	Stralsund (Strals.).
Strasburg, head revenue office	Strassburg (Strassbg.).
Stuttgart, head customs office	Stuttgart.
Suderwick, branch customs office I	Suderwick (Suderw.).
Tetschen, branch customs office I	Tetschen.
Thorn, head customs office	Thorn.
Tilsit, head customs office	Tilsit.
Trier, head revenue office	Trier.
Ulm, head customs office	Ulm.
Warnemünde, branch customs office I	Warnemünde (Warnem.).
Warnsdorf, branch customs office I	Warnsdorf (Warnsdf.).
Weener, branch customs office I	Weener.
Woyens, branch customs office I	Woyens.
Würzburg, head customs office	Würzburg (Würzbg.).
Zittau, head customs office	Zittau.
Zwickau, head customs office	Zwickau.

Proclamation,

Concerning the completion of [addition to] the list of importation and inspection places for meat imported past the customs line. Of June 24, 1903.

In accordance with § 13, paragraph 2, of the law concerning the inspection of food animals and of meat of June 3, 1900 (Reichs-Gesetzbl 547), the Bundesrath has resolved that to the list of the importation and inspection places for meat imported past the customs line (Appendix F to the proclamation of May 30, 1902—Centralblatt, supplement to No. 22) there should be added under the serial number 114a as an importation and inspection place for fresh meat:

Säckingen, branch customs office II at the Rhine Bridge.

THE IMPERIAL CHANCELLOR.
COUNT V. POSADOWSKY, *Acting.*

BERLIN, *June 24, 1903.*

Verzeichnis der Untersuchungsstellen für ausländisches Fleisch—Fortsetzung folgt.

Bezeichnung der Untersuchungsstelle. 1.	Zeichen der Untersuchungsstelle. 2.
Salzburg, Nebenzollamt I	Salzburg (Salzbg.).
Simbach, Hauptzollamt	Simbach.
Singen, Hauptsteueramt	Singen.
Stettin, Hauptsteueramt I	Stettin.
Stralsund, Hauptzollamt	Stralsund (Strals.).
Strassburg, Hauptsteueramt	Strassburg (Strassbg.).
Stuttgart, Hauptzollamt	Stuttgart.
Suderwick, Nebenzollamt I	Suderwick (Suderw.).
Tetschen, Nebenzollamt I	Tetschen.
Thorn, Hauptzollamt	Thorn.
Tilsit, Hauptzollamt	Tilsit.
Trier, Hauptsteueramt	Trier.
Ulm, Hauptzollamt	Ulm.
Warnemünde, Nebenzollamt I	Warnemünde (Warnem.).
Warnsdorf, Nebenzollamt I	Warnsdorf (Warnsdf.).
Weener, Nebenzollamt I	Weener.
Woyens, Nebenzollamt I	Woyens.
Würzburg, Hauptzollamt	Würzburg (Würzbg.).
Zittau, Hauptzollamt	Zittau.
Zwickau, Hauptzollamt	Zwickau.

Bekanntmachung,

betreffend die Ergänzung des Verzeichnisses der Einlass- und Untersuchungsstellen für das in das Zollinland eingehende Fleisch. Vom 24. Juni 1903.

Auf Grund des § 13 Abs. 2 des Gesetzes, betreffend die Schlachtvieh- und Fleischbeschau, vom 3. Juni 1900 (Reichs-Gesetzbl. S. 547) hat der Bundesrat beschlossen, dass in dem Verzeichnisse der Einlass- und Untersuchungsstellen für das in das Zollinland eingehende Fleisch (Anlage F zur Bekanntmachung vom 30. Mai 1902—Centralblatt, Beilage zu Nr. 22—) unter Lfd. Nr. 114a als Einlass- und Untersuchungsstelle für frisches Fleisch hinzutritt:

Säckingen, Nebenzollamt II an der Rheinbrücke.

BERLIN, *den 24. Juni 1903.*

DER REICHSKANZLER.
In Vertretung: GRAF V. POSADOWSKY.

Proclamation,

Concerning the stamp symbols of later designated inspection places for foreign meat. Of June 24, 1903.

In accordance with § 26, paragraph 3, of the regulations D with regard to the carrying out of the law concerning the inspection of food animals and of meat, of June 3, 1900, in addition to the proclamation concerning the marking of the inspected foreign meat, of February 10, 1903 (Centralblatt, p. 46), it is determined that as a stamp symbol, according to No. 4 of this proclamation, the following symbol should be exclusively used by the inspection office: "Säckingen, branch customs office II at the Rhine Bridge."

Säckingen, No. II.

THE IMPERIAL CHANCELLOR.
COUNT V. POSADOWSKY, *Acting.*

BERLIN, *June 24, 1903.*

Concerning the carrying out of the meat-inspection law.

To obviate differences which have occurred in the carrying out of the meat-inspection law with reference to the importation and examination of foreign meat, the ministers of ecclesiastical affairs etc., of agriculture etc., of finance and of commerce and industries, after agreement with the Imperial Chancellor have ordered the following:

1) Fresh blood of animals is considered according to § 1 B. B. D. as meat in the sense of § 4 of the meat-inspection law and consequently according to § 12, paragraph 2, No. 1, R.-G. can be imported past the customs line only "in entire carcasses." Whether *salted* blood can be considered as prepared meat in the sense of § 12, paragraph 2, No. 2, R.-G. is doubtful. The weight of opinion of experts however is in favor of the view that also strongly salted blood has not essentially lost the properties of fresh blood, and for this reason is subject to the principles for the importation of fresh meat. However even if salted blood is considered like prepared meat the inadmissibility of importation results from the fact that the reliable establishing of harmlessness to human health required according to § 12, paragraph 2, No. 2, R.-G. is impossible in the case of blood imported not in connection with entire carcasses. An examination of blood is indeed theoretically conceivable but impracticable. Further, also strong salting is not suited to taking from the blood of diseased animals the danger to human health. Upon [for] these grounds [reasons] salted blood—aside from the case in § 17, R.-G. (compare also § 29 B. B. D.)—can not be admitted to importation.

Advantage is taken of this opportunity to call attention to the fact that not only blood but also all other parts of warm-blooded animals so far as [when] they are suited as food for man are capable of importation in a fresh condition in so far as [when] they are found in natural con-

Bekanntmachung,

betreffend die Stempelzeichen nachträglich zugelassener Untersuchungsstellen für ausländisches Fleisch. Vom 24. Juni 1903.

Auf Grund des § 26 Abs. 3 der Ausführungsbestimmungen D zum Schlachtvieh- und Fleischbeschaugesetze vom 3. Juni 1900 wird im Anschluss an die Bekanntmachung, betreffend die Kennzeichnung des untersuchten ausländischen Fleisches, vom 10. Februar 1903 (Centralblatt S. 46) bestimmt, dass als Stempelzeichen gemäss Nr. 4 dieser Bekanntmachung von der Untersuchungsstelle "Säckingen, Nebenzollamt II an der Rheinbrücke" ausschliesslich anzuwenden ist die Bezeichnung:

Säckingen, Nz. II.

BERLIN, *den 24. Juni 1903.*

DER REICHSKANZLER.
In Vertretung: GRAF V. POSADOWSKY.

Zur Ausführung des Fleischbeschaugesetzes.

Zur Beseitigung von Verschiedenheiten, die bei der Durchführung des Fleischbeschaugesetzes in Bezug auf die Einfuhr und Untersuchung ausländischen Fleisches hervorgetreten sind, haben die Minister der geistlichen etc. Angelegenheiten, für Landwirtschaft etc., der Finanzen und für Handel und Gewerbe im Einverständnisse mit dem Reichskanzler folgendes angeordnet:

1) Frisches Blut von Tieren gilt nach § 1 B. B. D. als Fleisch im Sinne des § 4 des Fleischbeschaugesetzes und kann demzufolge nach § 12 Abs. 2 Nr. 1 R.-G. nur in "ganzen Tierkörpern" in das Zollinland eingeführt werden. Ob *gesalzenes* Blut als zubereitetes Fleisch im Sinne des § 12 Abs. 2 Nr. 2 R.-G. angesehen werden kann, ist zweifelhaft. Die überwiegende Ansicht der Sachverständigen geht indes dahin, dass auch stark gesalzenes Blut die Eigenschaften des frischen Blutes im wesentlichen nicht verloren hat und deshalb den Grundsätzen für die Einfuhr frischen Fleisches unterliegt. Selbst wenn jedoch gesalzenes Blut dem zubereiteten Fleische gleich geachtet wird, ergibt sich die Unzulässigkeit der Einfuhr daraus, dass die nach § 12 Abs. 2 Ziffer 2 R.-G. erforderte zuverlässige Feststellung der Unschädlichkeit für die menschliche Gesundheit bei dem nicht in Verbindung mit ganzen Tierkörpern eingeführten Blut unmöglich ist. Eine Untersuchung von Blut ist zwar theoretisch denkbar, aber praktisch undurchführbar. Auch starkes Salzen ist ferner nicht geeignet, dem Blute von kranken Tieren die Gefährlichkeit für die menschliche Gesundheit zu nehmen. Aus diesen Gründen kann gesalzenes Blut—abgesehen von dem Falle des § 17 R.-G. (vergl. auch § 29 B. B. D.)—zur Einfuhr nicht zugelassen werden.

Bei dieser Gelegenheit wird darauf hingewiesen, dass nicht nur Blut, sondern auch alle anderen Teile von warmblütigen Tieren, sofern sie sich zum Genusse für Menschen eignen, in frischem Zustande nur

nection with the entire carcass or the half-carcasses. This applies especially also to such internal organs whose importation in connection [with the entire carcass or half-carcasses] is not made compulsory by a provision in § 6 B. B. D. Hence, for example, fresh fat or fresh casings which are not connected with a carcass may not be admitted to importation, and indeed not even when they are conveyed to the place of examination at the same time as the carcasses from which they are alleged to have come.

2) The importation of livers that have been cooked through, especially of swine's livers has heretofore been permitted [to take place] through a number of examination places, even when they did not attain the minimum weight of 4 kg. prescribed for pickled meat in § 12, paragraph 2, No. 2, R.-G. The conception that this provision with regard to the minimum weight shall apply merely to pickled and not also to cooked meat must, according to the wording and the history of the origin of the regulation cited, be considered as correct. Nevertheless the admission of cooked livers to importation does not appear consistent with the meat-inspection law. According to § 12, paragraph 2, No. 2, R.-G. prepared meat may be imported only when according to the manner in which it has been obtained and prepared dangers to human health are excluded according to experience *or* the harmlessness to human health can upon importation be established in a reliable way. Neither the one nor the other obtains for cooked livers. For, even the cooking of the livers can not make all animal and vegetable disease germs harmless; diseased infiltrations are not removed from the livers by cooking, thus livers with changes due to disease however thoroughly cooked through retain the properties of a highly spoiled, nauseous food stuff.

On the other hand the cooking of livers is better suited than any other process of preparation to conceal a diseased condition of this organ; especially fresh tubercular infiltrations, echinococci in an early stage of development, and cisticerci, etc. are changed in such a manner through cooking that either they are not to be recognized at all or become indistinct in such a manner as to render the examination more difficult.

For these and other reasons a reliable examination of cooked livers is impracticable.

3) As internal organs, especially of swine, singly for the most part do not attain the weight of 4 kg., in several examination places an importation of such organs in connection with one another and with various other parts of the animal in a *pickled* condition has developed. For example parts of the head (tongue etc.) of the swine are imported in connection with the lung, liver, heart etc. in order thereby to comply with the provision with regard to the minimum weight in § 12, paragraph 2, No. 2, R.-G.

insoweit einfuhrfähig sind, als sie sich in natürlichem Zusammenhang mit dem ganzen Tierkörper oder den Tierhälften befinden. Dies gilt insbesondere auch für solche inneren Organe, deren Miteinführung im § 6 B. B. D. nicht zwingend vorgeschrieben ist. Beispielsweise dürfen also frisches Fett oder frische Därme, die sich ausser Zusammenhang mit einem Tierkörper befinden, zur Einfuhr nicht zugelassen werden, und zwar auch dann nicht, wenn sie zugleich mit den Tierkörpern, von denen sie angeblich herrühren, der Untersuchungsstelle zugeführt werden.

2) Die Einfuhr durchgekochter Lebern, insbesondere von Schweinslebern, ist bisher über eine Reihe von Untersuchungsstellen zugelassen worden, selbst wenn sie das für Pökelfleisch in § 12 Abs. 2 Nr. 2 R.-G. vorgeschriebene Mindestgewicht von 4 kg nicht erreichten. Die Auffassung, dass diese Mindestgewichtvorschrift lediglich auf gepökeltes und nicht auch auf gekochtes Fleisch Anwendung zu finden hat, muss nach dem Wortlaute und der Entstehungsgeschichte der angeführten Bestimmung als zutreffend angesehen werden. Gleichwohl erscheint die Zulassung gekochter Lebern zur Einfuhr mit dem Fleischbeschaugesetze nicht vereinbar. Nach § 12 Abs. 2 Nr. 2 R.-G. darf zubereitetes Fleisch nur eingeführt werden, wenn nach der Art seiner Gewinnung und Zubereitung Gefahren für die menschliche Gesundheit erfahrungsgemäss ausgeschlossen sind *oder* die Unschädlichkeit für die menschliche Gesundheit sich in zuverlässiger Weise bei der Einfuhr feststellen lässt. Weder das eine noch das andere trifft für gekochte Lebern zu. Denn auch das Kochen der Lebern vermag nicht alle tierischen oder pflanzlichen Krankheitskeime unschädlich zu machen; krankhafte Einlagerungen werden durch das Kochen aus den Lebern nicht entfernt, krankhaft veränderte Lebern behalten also auch bei noch so gründlicher Durchkochung die Eigenschaften eines hochgradig verdorbenen, ekelerregenden Nahrungsmittels bei.

Andererseits ist das Kochen der Lebern mehr als jedes sonstige Zubereitungsverfahren geeignet, eine krankhafte Beschaffenheit dieses Organs zu verdecken; vor allem werden frische tuberkulöse Einlagerungen, in früher Entwickelung befindliche Echinokokken und Cisticerken etc. durch das Kochen derart verändert, dass sie entweder überhaupt nicht zu erkennen sind oder in einer die Untersuchung erschwerenden Weise undeutlich werden.

Aus diesen und anderen Gründen ist eine zuverlässige Untersuchung gekochter Lebern unausführbar.

3) Da innere Organe, namentlich vom Schwein, einzeln meist nicht das Gewicht von 4 kg erreichen, hat sich an mehreren Untersuchungsstellen eine Einfuhr solcher Organe im Zusammenhang miteinander und mit verschiedenen sonstigen Tierteilen in *gepökeltem* Zustande entwickelt. Beispielsweise werden Kopfteile (Zunge etc.) des Schweins in Verbindung mit Lunge, Leber, Herz etc. eingeführt, um dadurch der Mindestgewichtvorschrift in §12 Abs. 2 Nr. 2 R.-G. zu genügen.

So far as [when] the connected parts actually weigh together at least 4 kg. and further it is established through the test prescribed in § 13 B. B. D a. that the organs etc. have lost the properties of fresh meat even in the inner layers, there is nothing standing in the way of the admission of portions of meat, connected in such a way, to further examination and in case of a favorable result of the latter, to importation.

4) The ordering of foreign prepared fat frequently takes place upon test. Hence not infrequently there are imported past the customs line fat samples in small single shipments of inconsiderable weight. By an examination—of such fat shipments—corresponding exactly to the regulations of the Bundesrath concerning the carrying out [of the law] usually the greater part of the fat content would be used up, besides, the expense of such an examination would be out of all proportion to the value, finally an examination in all cases and to a full compass does not appear necessary upon the ground of health, because as a rule the samples are not used as food for man. Hence the chemical examination of shipments of fat samples up to the weight of about 1 kg. can usually be omitted and is to be restricted to such cases in which the condition of the samples gives rise to special suspicion at the preliminary test, however without a rejection of the fat being pronounced [already] upon the ground of this preliminary test (compare § 21, paragraph under I B. B. D.).

5) According to § 1, paragraph 2 B. B. D. meat peptones until further notice are not considered as meat, hence also are not subject to the regulations of the meat-inspection law and can indiscriminately be admitted to importation.

In § 3, paragraph 7 B. B. D., among those preparations of meat which are to be considered as sausages or other mixtures of chopped meat and therefore according to § 12, paragraph 1, R.-G. are excluded from importation "powdered meat and meat meal (meat meal food excepted) with or without admixtures" are mentioned.

Meat peptones are now imported from abroad partly in a liquid or lard-like condition, partly in a powdered condition, in the latter [condition] to be used especially for the purpose of preparing nutritive media for scientific experiments with disease germs etc. In view of the regulation mentioned in § 3, paragraph 4, B. B. D. doubts have arisen as to whether peptones resembling meat meal can be admitted to importation. Until further notice meat peptones intended for the preparation of nutritive media even when they have the outward appearance of powdered meat are not to be considered as meat in the sense of the meat-inspection law and are to be admitted to importation without examination.

6) It has been established that there was present in imported meat boracic acid, concerning which according to the circumstances of the

Sofern die zusammenhängenden Teile tatsächlich zusammen mindestens 4 kg schwer sind und ferner durch in § 13 B. B. D. a. vorgeschriebene Prüfung festgestellt wird, dass die Organe etc. auch in den inneren Schichten die Eigenschaften frischen Fleisches verloren haben, steht der Zulassung derartig miteinander verbundener Fleischteile zur weiteren Untersuchung und bei günstigem Ausfalle der letzteren zur Einfuhr nichts entgegen.

4) Die Bestellung ausländischen zubereiteten Fettes erfolgt häufig nach Probe. Es gehen daher nicht selten in das Zollinland Fettproben in kleinen Einzelsendungen von unbedeutendem Gewicht ein. Durch eine den Ausführungsbestimmungen des Bundesrats genau entsprechende Untersuchung derartiger Fettsendungen würde gewöhnlich der grössere Teil des Fettinhaltes verbraucht werden, die Kosten einer solchen Untersuchung würden auch in keinem Verhältnisse zu dem Werte stehen, endlich erscheint eine Untersuchung in allen Fällen und in vollem Umfang aus gesundheitlichen Gründen nicht erforderlich, weil die Proben regelmässig nicht zum Genusse für Menschen verwendet werden. Die chemische Untersuchung von Fettprobensendungen bis zum Gewichte von etwa 1 kg kann daher für gewöhnlich unterbleiben und ist auf solche Fälle zu beschränken, in denen die Beschaffenheit der Proben bei der Vorprüfung zu besonderem Verdacht Anlass gibt, ohne dass doch bereits auf Grund dieser Vorprüfung eine Zurückweisung des Fetts ausgesprochen wird (vergl. § 21 Abs. unter I B. B. D.).

5) Nach § 1 Abs. 2 B. B. D. gelten Fleischpeptone bis auf weiteres nicht als Fleisch, unterliegen daher auch nicht den Bestimmungen des Fleischbeschaugesetzes und können ohne Unterschied zur Einfuhr zugelassen werden.

In § 3 Abs. 7 B. B. D. sind unter denjenigen Erzeugnissen aus Fleisch, die als Würste oder sonstige Gemenge aus zerkleinertem Fleisch anzusehen und deshalb nach § 12 Abs. 1 R.-G. von der Einfuhr ausgeschlossen sind, "Fleischpulver und Fleischmehl (ausgenommen Fleischfuttermehl) mit oder ohne Zusätze" aufgeführt.

Fleischpeptone werden nun aus dem Auslande teils in flüssigem oder schmalzartigem, teils in gepulvertem Zustande eingeführt, in letzterem namentlich zu dem Zweck, um zur Herstellung von Nährböden für wissenschaftliche Versuche mit Krankheitserregern etc. verwendet zu werden. Im Hinblick auf die erwähnte Bestimmung im § 3 Abs. 4 B. B. D. sind Zweifel darüber entstanden, ob fleischmehlartige Peptone zur Einfuhr zugelassen werden können. Bis auf weiteres sind zur Herstellung von Nährböden bestimmte Fleischpeptone, auch wenn sie sich äusserlich als Fleischpulver darstellen, als Fleisch im Sinne des Fleischbeschaugesetzes nicht anzusehen und ohne Untersuchung zur Einfuhr zuzulassen.

6) Es ist festgestellt worden, dass in eingeführtem Fleische Borsäure vorhanden war, von der nach Lage der Sache angenommen

case the assumption could be made that it had not been added intentionally to the meat for preservation but had found its way into the meat merely accidentally, for example, from the packing material which formerly was used for the shipment of wares containing boracic acid.

In view of the fact that according to the purpose of § 21, R.-G. and of the regulations issued by the Bundesrath concerning the carrying out [of the law] the importation of meat containing boracic acid is to be considered as absolutely prohibited, such meat can not be admitted to importation, on the contrary is to be rejected from importation.

werden konnte, dass sie nicht absichtlich zur Haltbarmachung dem Fleische zugesetzt worden, sondern nur zufällig, z. B. aus dem Verpackungsmaterial, das früher zum Versand borsäurehaltiger Waren benutzt worden war, in das Fleisch übergegangen war.

Im Hinblick darauf, dass nach der Absicht des § 21 R.-G. und der dazu vom Bundesrat erlassenen Ausführungsbestimmungen die Einfuhr von borsäurehaltigem Fleische schlechthin als verboten zu erachten ist, kann derartiges Fleisch nicht zur Einfuhr zugelassen werden, ist vielmehr von der Einfuhr zurückzuweisen.

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[Continued from 2d page of cover.]

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Dr. F. D. Ketchum, South St. Paul, Minn.
Dr. W. B. Lincoln, Union Stock Yards, Nashville, Tenn.
Dr. C. Loveberry, care Frye-Bruhn Co., Seattle, Wash.
Dr. H. D. Mayne, Malone, N. Y.
Dr. J. Miller, care John Morrell & Co., Ottumwa, Iowa.
Dr. J. C. Milnes, care John Cudahy Co., Wichita, Kans.
Dr. C. L. Morin, St. Albans, Vt.
Dr. A. B. Morse, care The Agar Packing Co., Des Moines, Iowa.
Dr. W. J. Murphy, care Springfield Provision Co., Brightwood, Mass.
Dr. W. N. Neil, care The Rath Packing Co., Waterloo, Iowa.
Dr. A. J. Payne, care Union Stock Yards, Cincinnati, Ohio.
Dr. F. M. Perry, Fort Fairfield, Me.
Dr. A. J. Pistor, care New York Hotel, Fremont, Nebr.
Dr. G. W. Pope, Animal Quarantine Station, Athenia, N. J.
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Dr. G. W. Ward, Newport, Vt.
Dr. B. P. Wende, Live Stock Exchange Building, East Buffalo, N. Y.
Dr. W. H. Wray, 21 Railway Approach, London Bridge S. E., London, England.
Dr. C. H. Zink, care Western Packing Co., Denver, Colo.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY—Bulletin No. 51.

D. E. SALMON, D. V. M., Chief of Bureau.

THE AVAILABLE ENERGY OF TIMOTHY HAY.

INVESTIGATIONS WITH THE RESPIRATION CALORIMETER,

IN COOPERATION WITH

THE PENNSYLVANIA STATE COLLEGE AGRICULTURAL
EXPERIMENT STATION.

BY

HENRY PRENTISS ARMSBY, Ph. D., and J. AUGUST FRIES, B. S.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 10, 1903.

Sir: I have the honor to transmit herewith a manuscript dealing with "The available energy of timothy hay." This work comprises the records of a careful and difficult experiment which has been carried on by Dr. H. P. Armsby and J. August Fries at the Pennsylvania Agricultural Experiment Station, in cooperation with this Bureau. I recommend that this manuscript be published as Bulletin No. 51 of the series of this Bureau.

Respectfully,

D. E. Salmon,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

STATE COLLEGE, PENN., *August 10, 1903.*

SIR: I have the honor to submit herewith a report upon the first series of experiments with the respiration calorimeter constructed at The Pennsylvania State College Agricultural Experiment Station by the cooperation of that station and the Bureau of Animal Industry of the United States Department of Agriculture. The apparatus is modeled after the one devised by Professors Atwater and Rosa, of Wesleyan University, Middletown, Conn., for investigations upon human nutrition, with such modifications as were necessary to adapt it to experiments with domestic animals. Special acknowledgment is due Professor Atwater and his associates for freely placing at our disposal the results of the experience gained in the construction of their apparatus and for many valuable suggestions as to improvements.

This first series of experiments with a new and complicated apparatus was much more successful than might have been anticipated. While the results in some directions require the confirmation of further experiments, they open up interesting lines of investigation, while they possess a certain interest as being, so far as we are aware, the first actual determinations of the heat production of an agricultural animal, and we therefore feel justified in presenting them as a report of progress. As the consequence of an entire recomputation, the figures here reported differ somewhat from those contained in the preliminary account of the experiments contained in the Proceedings of the Society for the Promotion of Agricultural Science for 1902.

The details of the experiments, especially of the determinations with the respiration calorimeter, have been in the hands of Mr. Fries, to whose untiring labors the larger share of their success is due. Acknowledgment should also be made of the skill and faithfulness of our assistants, Messrs. C. W. Norris, J. B. Robb, T. M. Carpenter, and N. W. Buckhout, in the execution of the laborious respiration and calorimetric experiments, and of the cooperation of the chemical division of the station, under the direction of Dr. William Frear, in the examination of feeds and excreta, Dr. C. A. Browne, jr., having had general charge of the reception and care of samples, and having executed the determinations of carbon and hydrogen, while the determinations of heats of combustion have been made by Mr. Norris. The weighing and sampling of feed and excreta were skillfully performed by Mr. A. K. Risser, who also had charge of the records of the digestion work.

Very respectfully,
HENRY PRENTISS ARMSBY,
Expert in Animal Nutrition.

D. E. SALMON, D. V. M.,
Chief of Bureau of Animal Industry.

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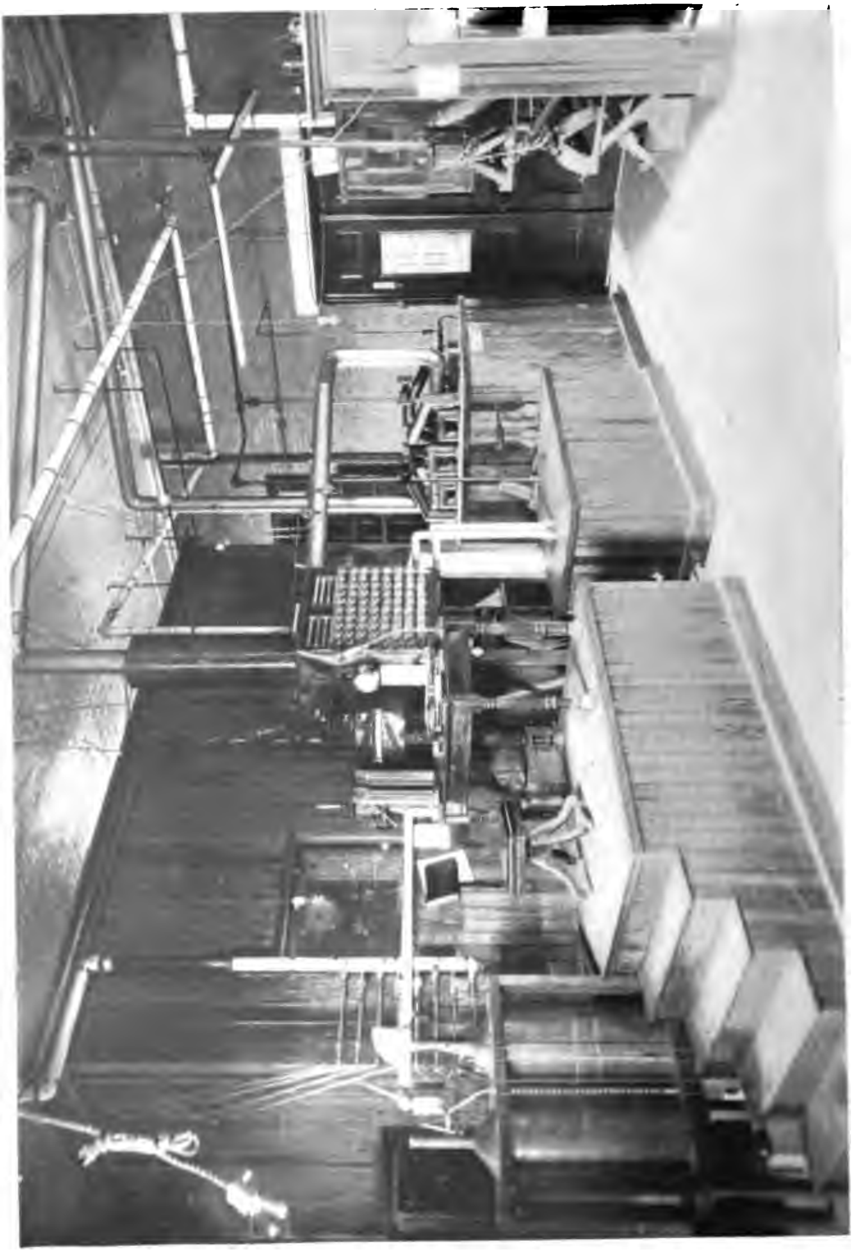
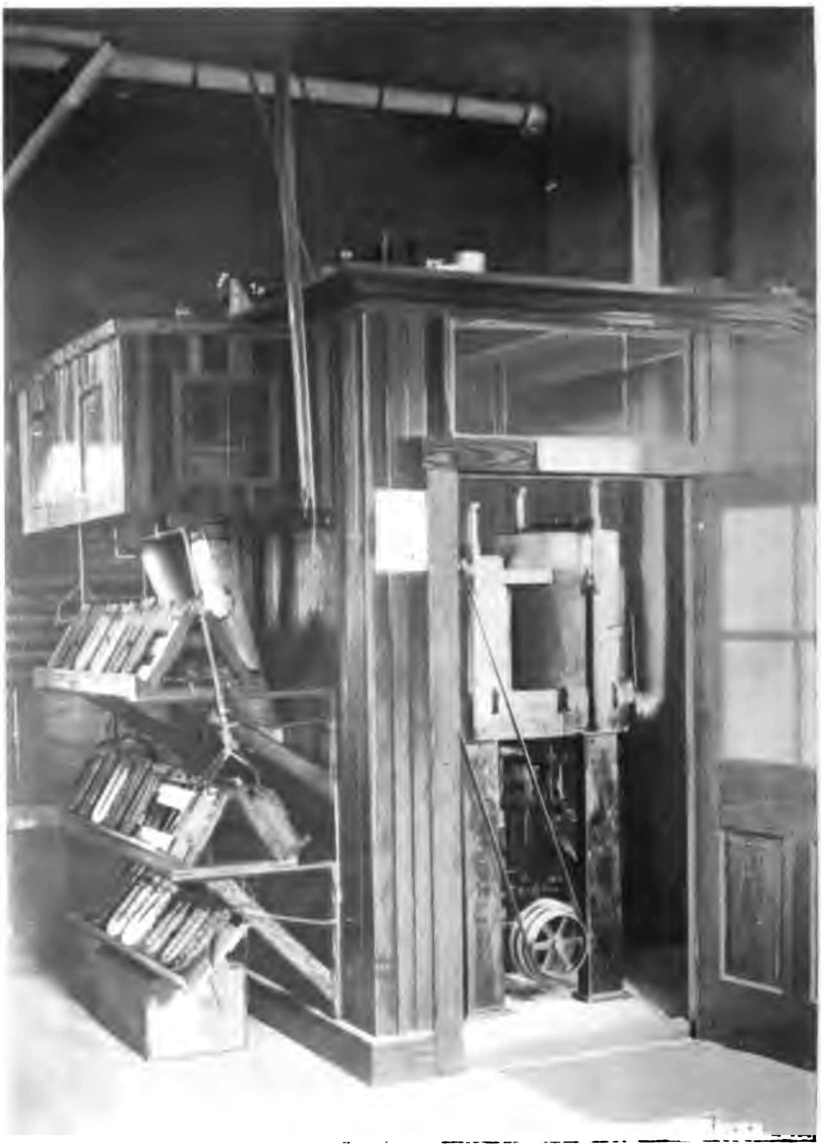


THE RESPIRATION CALORIMETER.



THE METER PUMP AND ABSORPTION TUBES.

THE AVAILABLE ENERGY OF TIMOTHY HAY.

By Henry Prentiss Armsby, Ph. D., and J. August Fries, B. S.

INTRODUCTORY.

The available energy of a feeding stuff in the narrower sense may be defined as the amount of energy which it is capable of contributing to the maintenance of the store of potential energy contained in the tissues of the animal. The simplest method of determining available energy, and one which has been extensively used in experiments upon carnivorous animals, consists in comparing the fasting metabolism of the animal with that upon a known amount of the food in question. The extent to which the loss of energy by the fasting animal is diminished by the consumption of the food affords a measure of its available energy in this sense. With herbivorous animals, for obvious reasons, it is impracticable to use the fasting state as a basis of comparison, since even when deprived of food the resorption of matter from the alimentary canal would undoubtedly continue for a considerable time. The comparison can be equally well made, however, with the metabolism upon a basal ration to which known quantities of the material in question are added. This method of experimentation has been extensively employed by Kellner in his determinations of the productive value of feeding stuffs and has been used in this investigation.

Timothy hay was selected as the subject of investigation as constituting a fairly definite farm product and also because of the somewhat greater simplicity of experiments with coarse fodder alone. This was an advantage which, however, had to be sacrificed later on account of the poverty of the hay in protein, linseed meal being added to supply the lack. Starting with a basal ration of hay and a small amount (400 grams per day) of linseed meal, the total ration being considerably below the maintenance requirement, three different amounts of the hay experimented upon were added in as many periods and the balance of carbon, nitrogen, and energy determined in each period.

It was originally intended to make the experiment upon two animals, but, owing to the limited time available for the work and the difficulty of selecting suitable animals, one only was finally used (No. 1). This animal was purchased in the Pittsburg market in the fall of 1900. At the time of the experiment it was about 3 years old. The breeding of the animal was unknown, but it apparently contained more or less Shorthorn blood.

DESCRIPTION OF THE EXPERIMENT.

ANALYTICAL METHODS.

The analytical methods employed for the analysis of the feed and excreta were substantially those recommended by the Association of Official Agricultural Chemists. Pentosans were determined by Kröber's modification of Tollens and Krüger's method.[a] The nitrogen of the feces was determined in the fresh material by König's method and the nitrogen of the urine by direct oxidation by the Kjeldahl method. In the computation of proteids from proteid nitrogen, Ritthausens factor 5.5 was used for the linseed meal and the conventional factor 6.25 for the timothy hay. The nonproteids were computed from the nonproteid nitrogen by multiplication by 4.7, the factor for asparagin. The pepsin-insoluble nitrogen of food and feces was determined by the method of G. Kühn.[b] The ordinary analytical methods were employed for the determination of carbon and hydrogen. The heats of combustion of the food and excreta were determined by means of the Atwater-Hempel bomb calorimeter.

THE FEEDS.

Hay.—The hay used was well-cured timothy, grown on the station farm in the summer of 1901. It was cut July 2 and housed July 3. About 2 tons of this hay were run through a feed cutter on November 8, 1901. The machine used was one which employs a blast of air to deliver the cut material, and the result of this was that the lighter parts of the hay were blown out and practically lost, leaving a residue of rather inferior composition. The mass of cut hay was twice thoroughly mixed with shovels on the barn floor and then spread out evenly in a mass about 2 feet deep. A narrow ditch was cut diagonally through the mass, the cut hay being removed and carefully subsampled. A second ditch was then cut through on the opposite diagonal and a separate subsample taken from this hay. The subsamples were chopped fairly fine in a meat chopper, and a sample of about 4 or 5 kilograms of the chopped hay taken to the laboratory. These samples were air dried, coarsely ground while still warm, and again subsampled. In these last two samples the composition of the dry matter and its heat of combustion were determined. During the progress of the experiment a sample of hay was also taken at the time of weighing out for each period, or four samples in all. The close agreement of the results upon all these samples, as shown in the following table, demonstrates the substantial accuracy of the sampling:

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[a] Jour. f. Landw., v. 48, p. 357.

[b] Landw. Vers. Stat., v. 44, p. 188.

Composition of hay (dry matter).

Constituents and energy.	General samples.			Samples taken during experiments.			
	A.	B.	Average.	Period 1 (B).	Period 2 (C).	Period 3 (A).	Period 4 (D).
Ash ....per cent..	4.36	4.91	4.64	4.55	4.60	4.63	4.67
Proteids ....do....	5.34	5.36	5.35	4.79	4.72	4.74	5.37
Nonproteids ....do....				.20	.17	.26	.32
Crude fiber ....do....	39.57	38.20	38.92	38.50	38.50	38.62	38.81
Nitrogen-free extract...do....	48.79	49.31	49.01	49.67	49.84	49.58	48.26
Ether extract ....do....	1.94	2.22	2.08	2.29	2.17	2.17	2.57
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pentosans ....do....	23.92	24.07	24.00	....	....	....	....
Total carbon............do....	....	....	....	46.71	46.19	46.45	46.53
Total nitrogen ....do....	.854	.858	.856	.809	.792	.814	.926
Proteid nitrogen........do....	.777	.760	.769	.767	.756	.758	.858
Heat of combustion, Calories per gram	4.549	4.558	4.554	4.595	4.551	4.527	4.556

Linseed meal.—The comparative poverty of the hay in protein, as shown by the above figures, together with the results of a preliminary digestion experiment, which revealed a low percentage digestibility of the protein and a material loss of nitrogenous tissue by the animal, showed that it would be necessary to add some proteid material to the basal ration. New-process linseed meal was selected for this purpose. One hundred pounds of the meal were thoroughly mixed and set aside especially for this experiment. The four samples taken during the several periods showed the composition given in the following table, the agreement of the results being very satisfactory:

Composition of linseed meal (dry matter).

Constituents and energy.	Period 1 (B).	Period 2 (C).	Period 3 (A).	Period 4 (D).
Ash ....per cent..	5.26	5.41	5.35	5.36
Proteids..do....	31.18	30.56	31.17	30.36
Nonproteids ....do....	2.60	2.59	2.46	3.12
Crude fiber...do....	8.69	9.25	8.92	9.21
Nitrogen-free extract.................................do....	42.08	42.12	41.87	41.65
Ether extract ....do....	10.19	10.07	10.23	10.30
	100.00	100.00	100.00	100.00
Total carbon.....................................per cent..	48.12	48.43	48.20	48.71
Total nitrogen ....do....	6.223	6.107	6.190	6.184
Proteid nitrogen ....do....	5.668	5.556	5.667	5.520
Heat of combustion ....Calories per gram..	5.106	5.094	5.097	5.111

PERIODS AND RATIONS.

During the latter part of October and through November, 1901, the two steers were fed approximately a maintenance ration of uncut hay. Beginning November 30, a digestion trial upon the timothy hay alone was carried out with both steers, the preliminary feeding extending from November 30 to December 9, inclusive, and the digestion period proper, during which the excreta were collected, from December 10 to 19, inclusive.

Following this digestion period, steer No. 1 was fed daily about 15 pounds of uncut hay until February 22, 1902, when the experiment proper began. At that date the animal was taken from the barn to the calorimeter building and the feeding with the experimental rations begun. The following table shows the dates of the several periods and the rations fed. During the first period the preliminary feeding covered ten days, and the succeeding digestion period seven days. The subsequent periods were of two weeks each, the first week being regarded as preliminary. It will be noted that the smallest ration was fed in the third period. As a matter of convenience in discussion, the several periods have also been designated by letters, and in the following discussion of the results they are referred to by these letters and considered in the order of magnitude of the rations:

Dates and rations.

Period—		Date.		Ration.	
No.	Letter.	Preliminary period.	Digestion period.	Timothy hay.	Linseed meal.
				Kilograms.	*Kilogram.*
1	B	Feb. 23–Mar. 4	Mar. 5–11	4.531	0.400
2	C	Mar. 12–18	Mar. 19–25	5.750	.400
3	A	Mar. 26–Apr. 1	Apr. 2–8	3.250	.400
4	D	Apr. 9–15	Apr. 16–22	7.000	.400

LIVE WEIGHTS.

During the feeding in the barn, including the preliminary digestion experiment, the animal was weighed daily at 1 p. m., immediately before watering, and also immediately after, the difference being taken as representing the amount of water consumed. During the experiment proper the same hours were observed with the exception of the days when the animal was in the respiration calorimeter, in which case the weight was taken immediately before entering and immediately after leaving the apparatus. The figures for live weight and amount of water consumed are given in Table I of the Appendix in connection with the weights of the excreta, and are also shown graphically on Diagram I.

DIGESTIBILITY OF THE RATIONS.

WEIGHING AND SAMPLING OF THE FEED.

y.—The hay, both in the preliminary digestion trial and in the al periods of the experiment proper, was weighed out in advance th bags, a day's ration in a bag. In filling the bags the mass of as worked into from the side, taking all the material down to the . While the bags were being filled two or three large handfuls of hay were taken from each bag and set aside in a covered vessel. ediately after the weighing this sample was chopped in a meat per, thoroughly mixed, and a sample of 1,000 to 1,500 grams taken ediately to the laboratory in a covered vessel for determination of matter and of the composition of the latter, with the results wn in the table on page 11.

Linseed meal.—The linseed meal required was also weighed out in vance for each period in glass fruit jars which were sealed and kept a cool place until used. At the time of weighing out a sample of 0 or 400 grams was drawn and taken immediately to the laboratory r determination of dry matter and its several ingredients, with the sults shown in the table on page 11.

Feeding.—In the preliminary digestion trial the day was regarded s beginning at 1 p. m. In the experiment proper 6 p. m. was taken s the beginning of the day as a matter of convenience in arranging for the work with the respiration calorimeter. Approximately one-half of the hay and linseed meal was given at this time and the remainder twelve hours later. Both were fed dry, the linseed meal being simply scattered over the hay.

Treatment of samples.—The samples, upon being received at the laboratory, were immediately weighed, air dried at a temperature of about 60° C., allowed to hang at ordinary temperature in heavy paper bags for several days, and then ground in a mill as rapidly as practicable, and preserved in sealed, glass-stoppered bottles. The analyses were made as promptly as practicable, although not in all cases immediately.

COLLECTION AND SAMPLING OF THE EXCRETA.

The animal was provided with the rubber duct described and illustrated in a previous publication,[a] for the collection of the feces, and with the ordinary urine funnel. During the experiment proper these were worn constantly, both during the preliminary days and the digestion period proper. The apparatus served its purpose excellently, loss of excreta occurring in very few instances.

During the digestion period the excreta were weighed promptly at the end of each twenty-four hours, a sample drawn, after thorough mixing, and taken at once to the laboratory for treatment. There one one-hundredth of the total excretion was weighed out and set aside for a composite sample, formaldehyde being employed as a preservative. At the close of the period these composite samples were thoroughly mixed. In the feces the total nitrogen in the fresh substance was determined by the König method and pepsin-insoluble nitrogen by Kühn's method, while a portion of the composite sample was also air dried at about 60° C. and the air-dry sample subjected to the usual methods of analysis, including the determination of its heat of combustion and of carbon and hydrogen. In the mixed sample of urine the total nitrogen, total carbon, carbon dioxide, hydrogen in organic combination, and heat of combustion were determined.

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[a] Penn. Experiment Station, Bulletin No. 42, p. 74.

DIGESTIBILITY OF THE HAY.

As already stated, a preliminary determination of the digestibility of the hay employed was made during November and December. In this trial steer No. 1 received daily 6.804 kilograms (15 pounds) and steer No. 2, 5.443 kilograms (12 pounds) of hay. The live weights, water consumed, and weights of excreta during the digestion trial proper are as shown in Table I of the Appendix.

The percentages of dry matter found in hay and feces were as follows:

	Per cent.
Hay:	
Preliminary perioa	87.93
Digestion period	88.03
Feces:	
Steer No. 1	18.77
Steer No. 2	19.95

The dry matter of the hay contained, in the preliminary period, 0.853 per cent and in the digestion period 0.775 per cent of total nitrogen, equivalent to 5.33 and 4.84 per cent, respectively, of protein. For the other ingredients the average results upon samples A and B were assumed. The dry matter of the feces had the composition shown in Table II of the Appendix.

Using the averages of the analyses for the preliminary and the digestion periods to represent the composition of the hay consumed, the results upon digestibility were as follows, the details of the computation being shown in Table III of the Appendix:

Percentage digestibility of hay.

Constituents and energy.	Steer No. 1.	Steer No. 2.
	Per cent.	*Per cent.*
Dry matter	56.92	56.60
Ash	44.56	44.15
Organic matter	57.52	57.20
Crude protein	38.56	39.62
Crude fiber	59.35	59.07
Nitrogen-free extract	58.95	58.46
Ether extract	35.58	35.04
Energy	52.78	53.09

The results upon the urine and the nitrogen balance were as follows:

Average weight of urine and percentage of nitrogen.

Animals.	Average weight of urine per day.	Nitrogen in urine.
	Grams.	*Per cent.*
Steer No. 1	3,677	0.70
Steer No. 2	3,769	.65

Daily nitrogen balance.

		Grams.
Steer No. 1:		
In food		48.73
In feces	29.94	
In urine	25.74	
In total excreta		55.68
Loss		6.95
Steer No. 2:		
In food		38.98
In feces	23.55	
In urine	24.50	
In total excreta		48.05
Loss		9.07

DIGESTIBILITY OF THE MIXED RATIONS.

The same general methods that have been described above were used in the several periods to determine the digestibility of the total rations. As already noted, steer No. 1 only was used for these trials, and the periods, with the exception of the first (Period B), were but two weeks long, the first week being regarded as preliminary. The results for the several periods were as shown below:

Period A (March 26 to April 8, 1902).

This was the third of the four periods, but being the one with the smallest ration it is considered first. The live weights and the weights of the excreta were as shown in Table I of the Appendix. The weight of urine includes 10 c. c. of formalin added as a preservative and, on April 5, 6, 7, and 8, 50 c. c. of distilled water employed to rinse out the tube. The animal entered the calorimeter April 1 and therefore no weight was taken on the 2d, while upon the 3d the weight was taken at 6 p. m. instead of at the regular time. On April 2 a small amount of urine was spilled in the calorimeter. After the animal left the apparatus, this was taken up as completely as possible with distilled water and the weight and nitrogen content of the whole determined. On two days small amounts of feces were also spilled, but were carefully collected and the weight and content of dry matter determined. A residue of 14.9 grams of uneaten hay was left during the two days in the calorimeter.

The following percentages of dry matter were contained in the several samples:

	Per cent.
Hay	88.66
Linseed meal	89.46
Feces	20.66
Feces spilled:	
April 2	57.58
April 5	31.29

The total amounts of dry matter consumed and excreted in the seven days of the digestion period, together with the averages per day, were, accordingly, as follows:

Feed and excreta.

Feed and excreta.	Fresh weight.	Dry matter.
Hay:	*Grams.*	*Grams.*
Total in 7 days	22,750.0	20,170.2
Uneaten	14.9	13.7
Eaten	22,735.1	20,156.5
Eaten per day	3,247.9	2,879.5
Linseed meal eaten per day	400.0	357.8
Feces:		
Collected in 7 days	45,112.0	9,320.1
Spilled in calorimeter April 2	64.1	37.0
Spilled in stall April 5	14.3	4.5
Total excretion	45,190.4	9,361.6
Daily excretion	6,455.8	1,337.4

The composition of the dry matter of the feeding stuffs has already been stated on page 11, and that of the dry matter of the feces is shown in Table II of the Appendix.

Basing the computation upon the above daily averages, the digestibility of the total ration, as shown in detail in Table III of the Appendix, was as follows:

Digestibility of the total ration.

Constituents and energy.	Total digested.	Percentage digestibility.
	Grams.	
Dry matter	1,899.9	58.69
Ash	68.8	45.14
Organic matter	1,831.1	59.36
Proteids	146.8	59.19
Nonproteids[a]	16.3	(100.00)
Crude fiber	642.6	56.17
Nitrogen-free extract	959.2	60.80
Ether extract	66.2	66.80
	Calories.	
Energy	8,427	56.71

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[a] Assumed to be wholly digestible.

If we assume that the pepsin-insoluble nitrogen of the feces represents the actual undigested proteids of the food, and that the nitrogen soluble in pepsin represents metabolic products, we have the following figures for the real digestibility of the proteids:

Proteids in ration	grams	248.0
Indigestible proteids in feces	do	82.4
Digestible	do	165.6
Percentage digestibility	per cent	66.77
Metabolic products	grams	18.8

It will be noted that in this period and one other the proteid nitrogen of the feces as ordinarily determined is less than the pepsin-insoluble nitrogen. It is assumed that this is due to an error in the determination of the former, although there is no direct evidence that such is the fact.

Period B (February 23 to March 11, 1902).

This was the first of the four periods in order of time. The preliminary feeding covered the ten days from February 23 to March 4, inclusive, and the digestion period proper the seven days from March 5 to March 11, inclusive. The animal entered the calorimeter March 4, consequently no live weight was taken on the 5th, and on the 6th was taken at 6 p. m., immediately after leaving the calorimeter. A small amount of feces was spilled in the calorimeter. This was collected at the completion of the test and its weight and content of dry matter determined. Four grams of hay, air-dry weight, were left uneaten in the calorimeter. In reporting weights of urine for March 7 and 9 an error of +1 kilogram was made and the aliquot taken for the composite sample was based on these erroneous weights. Accordingly these two days are given undue weight in the composite sample. The weights given in Table I of the Appendix, however, are the actual weights.

The following are the results of the determinations of dry matter in the several samples of this period:

	Per cent.
Hay:	
Preliminary period	88.75
Digestion period	88.63
Linseed meal	88.67
Feces	20.15
Feces spilled	25.29

Using the average percentage of dry matter in the hay for the preliminary and the digestion periods as the basis of computation, the amounts of dry matter eaten and excreted were as follows:

Feed and excreta.

Feed and excreta.	Fresh weight.	Dry matter.
Hay:	*Grams.*	*Grams.*
Total in 7 days	31,717.0	28,129.8
Uneaten	[a]4.0	3.8
Eaten	31,713.0	28,126.0
Eaten per day	4,530.4	4,018.0
Linseed meal eaten per day	400.0	354.7
Feces:		
Collected	59,705.0	12,030.5
Spilled in calorimeter	565.0	142.9
Total excretion	60,267.0	12,173.4
Daily excretion	8,609.6	1,739.1

[a] Air-dry weight. Assumed to have had same moisture content as air-dry hay, namely, 4.80 per cent.

Computed as in Period A, the results upon digestibility, as shown in Table III of the Appendix, were as follows:

Digestibility of the total ration.

Constituents and energy.	Total digested.	Percentage digestibility.
	Grams.	
Dry matter	2,633.6	60.23
Ash	93.9	46.60
Organic matter	2,539.7	60.89
Proteids	173.2	57.15
Nonproteids[a]	17.2	(100.00)
Crude fiber	961.5	60.94
Nitrogen-free extract	1,309.3	61.04
Ether extract	78.5	61.28
	Calories.	
Energy	11,700	57.76

[a] Assumed to be wholly digestible.

Proteids in ration	grams	303.1
Indigestible proteids in feces	do	105.7
Digestible	do	197.4
Percentage digestibility	per cent	65.13
Metabolic products	grams	24.2

Period C (March 12 to March 25, 1902).

This was the second of the four periods, immediately following Period B. The preliminary feeding extended from March 12 to 18, inclusive, and the digestion period proper from March 19 to 25, inclusive. The animal entered the calorimeter on the 18th, so that no weight was taken on the 19th, and that on the 20th was taken at 6 p. m. There were small mechanical losses of excreta, as shown in Table I of the Appendix. In particular, there was a loss of urine during the calorimeter experiment which was not discovered until several days afterwards. The partially dried residue was then taken up with distilled water, the weight of the solution and its nitrogen content determined, and the content of carbon and of energy assumed to be proportional to the nitrogen. By a misunderstanding two aliquot samples of urine were based upon the net weight, not including the preservative and wash water, so that there is a slight error in sampling in this period.

The percentages of dry matter in the several samples of this period were:

	Per cent.
Hay	89.22
Linseed meal	89.02
Uneaten hay:	
In calorimeter	92.14
In stall	79.65
Feces	18.32
Feces spilled:	
In calorimeter	28.04
In stall	36.45

The average amounts of dry matter eaten and excreted daily were, accordingly, as follows:

Feed and excreta.

Feed and excreta.	Fresh weight.	Dry matter.
Hay:	*Grams.*	*Grams.*
Total in 7 days	40,250.0	35,911.1
Uneaten—		
In calorimeter	27.1	25.0
In stall	20.5	16.3
Total uneaten	47.6	41.3
Eaten	40,202.4	35,869.8
Eaten per day	5,743.2	5,124.3
Linseed meal eaten per day	400.0	356.1
Feces:		
Collected	89,496.0	16,395.7
Spilled—		
In calorimeter	149.0	41.8
In stall	117.6	42.9
Total excretion	89,762.6	16,480.4
Daily excretion	12,823.2	2,354.3

Summarizing the detailed computations of the Appendix, we have the following figures for the digestibility of the ration:

Digestibility of the total ration.

Constituents and energy.	Total digested.	Percentage digestibility.
	Grams.	
Dry matter	3,126.1	57.05
Ash	112.1	43.96
Organic matter	3,014.0	57.68
Proteids	179.8	51.27
Nonproteids[a]	17.9	(100.00)
Crude fiber	1,121.0	55.89
Nitrogen-free extract	1,609.7	59.53
Ether extract	85.6	58.19
	Calories.	
Energy	13,679	54.42

[a] Assumed to be wholly digestible.

Proteids in ration	grams	350.7
Indigestible proteids in feces	do	143.2
Digestible	do	207.5
Percentage digestibility	per cent	59.16
Metabolic products	grams	27.7

Period D (April 9 to 22, 1902).

This was the last period of the series. The preliminary feeding extended from April 9 to 15 and the digestion period proper from the 16th to the 22d, inclusive. The animal entered the calorimeter on the 15th. On the 19th there was a small loss of feces in the stall. This was collected as completely as possible by mechanical means and an aliquot portion of it added to the sample of the main portion.

The several samples of this period contained the following percentages of dry matter:

	Per cent.
Hay	87.07
Linseed meal	88.6
Hay uneaten:	
April 18	92.02
April 22	43.73
Feces	17.72
Feces spilled	74.28

The following tables show the average amounts of dry matter eaten and excreted daily in this period and the final results of the computations of digestibility contained in the Appendix:

Feed and excreta.

Feed and excreta.	Fresh weight.	Dry matter.
Hay:	*Grams.*	*Grams.*
Total in 7 days	49,000.0	42,664.3
Uneaten April 18	54.0	49.7
Uneaten April 22	31.7	13.9
Total uneaten	85.7	63.6
Total eaten	48,914.3	42,600.7
Eaten per day	6,987.8	6,085.8
Linseed meal eaten per day	400.0	354.4
Feces:		
Collected	116,292.0	20,606.9
Spilled in calorimeter	42.1	31.3
Total excretion	116,334.1	20,638.2
Daily excretion	16,619.2	2,948.3

Digestibility of the total ration.

Constituents and energy.	Total digested.	Percentage digestibility.
	Grams.	
Dry matter	3,491.9	54.22
Ash	121.9	40.22
Organic matter	3,370.0	54.92
Proteids	224.8	51.75
Nonproteids[a]	30.6	(100)
Crude fiber	1,238.8	51.74
Nitrogen-free extract	1,760.2	57.06
Ether extract	115.6	59.93
	Calories.	
Energy	15,295.0	51.78

[a] Assumed to be wholly digestible.

Total proteids of food	grams..	434.4
Indigestible proteids of feces	do....	166.4
Digestible	do....	268.0
Per cent digested	per cent..	61.7
Metabolic products	grams..	43.2

THE URINARY EXCRETION.

Table IV of the Appendix, based upon the weights recorded in Table I, shows the total excretion of nitrogen, carbon, and potential energy in the urine. In those cases in which some was spilled, the nitrogen content was determined directly, as already noted, and it has been assumed that the content of carbon and of energy was proportional to the nitrogen. The following table gives a summary of the average daily excretion:

Average daily excretion in urine.

Period.	Nitrogen.	Carbon.	Energy.	Energy per gram of carbon.
	Grams.	*Grams.*	*Calories.*	*Calories.*
A	36.32	88.1	853	9.68
B	33.69	101.3	965	9.53
C	34.11	117.6	1,110	9.44
D	32.41	124.2	1,210	9.74

It will be noted that the average energy per gram of carbon in these experiments is somewhat less than that found by Kellner,[a] the average being 9.6 Calories instead of 10.03 Calories. It, however, corresponds almost exactly with Kellner's results for lean animals on a maintenance ration.

GROWTH OF EPIDERMAL TISSUE.

Except in Period B, the steer was thoroughly brushed immediately before entering the calorimeter and after leaving it, and the hair, dandruff, etc., in the latter case collected. To this was added the small amount brushed up from the floor of the calorimeter. In these samples determinations of nitrogen, carbon, and energy were made with the following results:

Composition of hair, dandruff, etc.

Constituents and energy.	Period A.	Period C.	Period D.
Weight ....grams..	35.8	42.1	32.9
Dry matter ....per cent..	94.22	[b]94.78	94.57
Weight of dry matter ....grams..	33.7	39.9	31.1
In dry matter:			
Nitrogen—			
Percentage	7.571	[b]6.49	7.014
Weight ....grams..	2.71	2.73	2.18
Carbon—			
Percentage	45.87	[b]41.68	45.23
Weight ....grams..	16.42	17.55	14.07
Energy—			
Per gram ....Calories..	5.020	[b]4.568	5.025
Total ....do....	179.7	192.3	156.3

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[a] Landw. Vers. Stat., v. 53, p. 439.

[b] Air-dry matter.

Average composition of hair, dandruff, etc.

On the average of the three periods, the amounts of nitrogen, carbon, and energy contained in the brushings were as follows:

Constituents and energy.	Total.	Per day.
Nitrogen ....grams..	2.54	1.3
Carbon ....do....	16.01	8.0
Energy ....Calories..	176.1	88.0

In the computations on the following pages it has been assumed that these figures represent the normal rate of production of hair, epidermis, etc., by the animal during the experiment. They do not, of course, include the matter and energy contained in the growth of hoofs and horns.

THE RESPIRATION CALORIMETER.

The apparatus employed for the determination of the respiratory products and heat is a modification of the respiration calorimeter devised by Atwater and Rosa, and described in Bulletin No. 63 of the Office of Experiment Stations of the United States Department of Agriculture. Our apparatus is essentially the same as theirs, with such increase in size and modifications in details as were necessary to fit it for experiments on domestic animals. It is the intention to publish later a more detailed description of it, but the following outline, together with reference to the bulletin above named, will give a sufficient idea of its general nature.

THE RESPIRATION APPARATUS.

The respiratory part of the apparatus is, in principle, a Pettenkofer apparatus. The ventilation is maintained by means of a large mercurial pump, known as a meter pump, having a capacity, as used, of 50 liters per stroke and running at the rate of about fourteen strokes per minute, the total ventilation being, therefore, about 700 liters per minute. Before entering the apparatus, the external air is passed over ammonia expansion coils connected with an ice machine and thus deprived of the larger part of its moisture. After leaving the apparatus, the air passes through a series of four copper cans immersed in a brine bath cooled by the same machine. Most of the water contained in the outgoing air is deposited in the cans and weighed at the close of a period or subperiod.

A sample of the ingoing air is taken by an aspirator at the rate of about 200 liters in twelve hours. The outcoming air is automatically sampled by the meter pump, which delivers one two-hundredth of the total volume of air into each of two duplicate receivers, from which it is drawn through a series of absorption tubes by means of an auxiliary air pump.

The samples of both ingoing and outcoming air pass through six U tubes, the first two of which are filled with pumice stone saturated with sulphuric acid, the second two with soda lime, and the last two again with pumice stone and sulphuric acid. The increase in weight of the first pair of tubes is reckoned as water and that of the remaining four tubes as carbon dioxide. The second sulphuric acid tube in every case is used as a check and shows no material gain in weight.

One of the two samples of outcoming air, after passing through the absorption tubes as just noted, is conducted through a copper tube 2.5 cm. in diameter and 154 cm. long, filled with platinized kaolin maintained at a red heat, and then through a second set of absorption tubes. The increases in weight in the latter set represent, of course, the carbon and hydrogen of any combustible gases excreted by the animal. Preliminary tests showed that the apparatus as described is fully sufficient to oxidize the amounts of methane, etc., given off by the animal under the conditions of the experiment. As appears from the above statements, the determination of combustible gases was not duplicated, nor were any simultaneous determinations made upon the ingoing air. Numerous check tests upon the latter, however, were made, as noted below.

The apparatus as described is intended to determine both the carbon dioxide and water excreted by the animal. The results for the latter in the check tests, however, were not satisfactory, apparently on account of evaporation of water from the wooden platform in the apparatus, and the figures for water are not included in the following pages.

THE CALORIMETER.

The respiration apparatus, as above described, is also fitted up as an animal calorimeter. Through a series of copper pipes at the top of the respiration chamber a uniform current of cold water is constantly circulated. The temperature of this water on entering and leaving is read every four minutes by calibrated mercurial thermometers reading to 0.01° C., and the volume of water passing through is measured by means of copper meters holding 100 liters each. From these data the amount of heat brought out by the water current is readily computed.

The walls of the respiration chamber are double, the inner one being of sheet copper and the outer of sheet zinc, with a 7.5 cm. dead-air space between. This inner chamber is surrounded by two double wooden walls inclosing spaces of about 10 cm. between the outer zinc surface of the respiration chamber proper and the first wooden wall and between the latter and the second wooden wall, respectively.

The walls of the respiration chamber proper contain 1,008 iron German silver couples, arranged in two hundred and fifty-two groups of four each, distributed as uniformly as possible over top, bottom, and sides of the chamber. The junctions of the couples lie, respectively, in the plane of the copper and of the zinc, and the couples are connected in series to a reflecting galvanometer. Any difference in temperature between the inner copper wall and outer zinc wall is, of course, indicated by a corresponding deflection of the galvanometer. If the zinc wall is shown to be warmer than the copper wall, cold water is circulated through a series of brass pipes in the adjoining air space until equilibrium is restored. If the zinc wall is found to be cooler than the copper wall, the adjoining air space is heated by means of an electric current through German silver heating wires until the galvanometer stands at zero. This regulation is so delicate that with a little practice the copper-zinc wall of the respiration chamber may be maintained practically adiabatic with only minimal fluctuations, which are made to balance each other in the course of an experiment.

By means of a less delicate arrangement on the same plan, the air space between the two wooden walls is maintained at approximately the same temperature as the air space next the zinc wall, thus protecting the latter from fluctuations of room temperature. Frequent measurements of the temperature in the interior of the respiration chamber, both by mercurial thermometers and by means of delicate copper resistance thermometers, enable the withdrawal of heat by the water current to be so regulated as to maintain very nearly a constant temperature in the chamber.

A similar arrangement of thermo-electric couples, water jackets, and electric heating coils permits the temperature of the ingoing air to be kept the same as that of the outcoming air.

By these devices all loss of heat by radiation through the walls of the apparatus or in the air current is avoided and the total amount of heat evolved by the animal under experiment is represented by the heat carried off in the water current plus the latent heat of vaporization of the water removed in the air current. The latter quantity is computed from the weight of the water excreted. As noted on page 24, this determination was not satisfactory, but the error introduced into the heat computation is believed to be small, since any water evaporated from the platform in the calorimeter would reduce the amount of heat measured in the water current by the same amount that it increased that measured as latent heat of water vapor, provided there was no permanent cooling of the platform, which can hardly have occurred to any large extent.

CHECK TESTS.

External air.—As noted, a number of determinations of the combustible gases of the external air were made at different dates, the results of which have been discussed elsewhere[a] and a summary of which is contained in the following table:

Combustible gases in air.

Date.	Volume of air.	Water weighed.	Carbon dioxide weighed.	Per 100 liters air, at 0° C. and 760 mm.	
				Hydrogen.	Carbon.
	Liters.	*Gram.*	*Gram.*	*Milligram.*	*Milligram.*
October 18, 1901	850	0.0150	0.0030	0.22	0.11
November 4, 1901	1,250	.0320	.0115	.31	.28
February 3, 1902	2,450	.0025	.0040	.01	.05
April 24, 1902	2,400	.0530	.0265	.27	.33
May 6, 1902	1,200	.0300	.0105	.30	.26

As will be seen, the results are somewhat variable, but at the same time the absolute amounts found are so small as to make the error involved in using these corrections relatively insignificant as compared with the total amounts determined in the experiments on the animal. There appears to be some connection between the meteorological conditions and the amounts of carbon and hydrogen found. Accordingly, the correction derived from the test of February 3 has been applied in computing Periods A, B, and C, and the average of the results of April 24 and May 6 has been used in computing Period D, the meteorological conditions having been similar in the respective cases.

Alcohol check tests.—Several tests of the accuracy of the apparatus were made by burning known amounts of ethyl alcohol and determining the amounts of carbon dioxide, water, and heat evolved, exactly as in experiments with an animal. The alcohol was burned from a large Argand burner to which it was supplied from outside the calorimeter by means of a constant level apparatus. The flame appeared entirely colorless, but very small amounts of combustible gases, apparently consisting of carbon monoxide, were detected by passage over the platinized kaolin. After the lamp had been burning for some time and the apparatus had fully come into equilibrium the air current was shifted to fresh absorption apparatus and the experiment continued for the desired number of hours. The methods were in all respects similar to those of the experiments with the animal, and it seems unnecessary to consume space with a full description or tabulation of them. The theoretical amounts of carbon dioxide and water produced are computed on the assumption that the alcohol was pure ethyl alcohol. For the heat, on the contrary, the results of direct determinations of the heats of combustion of the samples of alcohol used are made the basis of the calculation. These results were:

	Calories per gram.
Sample of January 16 and 29	7.1773
Sample of April 29	7.2220

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[a] Fries: Soc. Prom. Agrl. Science, Proceedings, 1902, p. 110.

These figures are somewhat higher than the accepted value for ethyl alcohol and may indicate a slight admixture of higher alcohols.

The final results of the tests were as follows:

Results of alcohol check tests.

Date.	Number of hours.	Weight of alcohol.		Carbon dioxide.			Heat.		
		Hydrated.	Anhydrous.	Computed.	Observed.	Percentage observed.	Computed.	Observed.	Percentage observed.
		Grams.	*Grams.*	*Grams.*	*Grams.*		*Calories.*	*Calories.*	
January 16, 1902	6	564.85	511.41	977.30	963.15	98.5	3,670.54	3,752.64	102.2
January 29, 1902	6	592.86	536.77	1,025.77	1,017.86	99.2	3,852.66	3,876.76	100.6
April 29, 1902	11	975.34	879.14	1,680.04	1,665.14	99.1	6,347.39	6,395.38	100.8

Apparently there is a slight tendency to a minus error in the determination of carbon dioxide and to a plus error in that of heat.

DETERMINATIONS OF RESPIRATORY PRODUCTS.

As indicated on pages 15–20, a respiration trial was made during each of the four periods. Each respiration trial extended over forty-eight hours continuously, being divided into four subperiods of twelve hours each. The respiration trial began in each case at 6 p. m., but the animal was placed in the apparatus about five hours before this time, so that at the time of beginning the actual trial everything was in equilibrium.

It seems neither practicable nor necessary to reproduce in full the records of these trials, but the essential portions of them are tabulated in the Appendix. The general methods employed may be conveniently illustrated here by the records of the first subperiod of Period C.

RESIDUAL AIR.

Owing to variations in the rate of excretion of the respiratory products, the amounts of the latter contained in the air of the respiration chamber vary more or less at different times. In order to obtain a correction for this source of error, a sample of 25 liters of the air of the chamber was taken by means of an aspirator at the beginning of each subperiod and at the close of the last one, and in this sample water and carbon dioxide were determined by absorption by means of sulphuric acid and soda lime. The total volume of the chamber, up to the cans in which the outgoing water is condensed, is 12,678 liters. The average weight of the animal was 415 kilograms. Assuming a specific gravity of 1, this is equivalent to 415 liters, leaving the net capacity of the apparatus 12,263 liters. The slight errors arising from variations in the weight of the animal and the error in the assumed specific gravity are entirely insignificant. The table below gives the detailed results for the sample of residual air taken at the end of subperiod 1 of Period C. In computing these results it is assumed that the air in the aspirator was saturated with water vapor at the observed temperature:

Carbon and hydrogen in residual air.

Aspirator reading	liters	25
Temperature	degrees C	16.4
Barometer	millimeters	733.86
Tension of water vapor	do	13.89
Pressure of air	do	719.97
25 liters $\times \frac{720}{760} \times \frac{273}{289.4}$	liters, corrected	22.35
CO_2 weighed 0.1050 gram × 0.50086	do	0.05
Total volume of sample, dry	do	22.40
H_2O weighed 0.1349 gram × 1.2434	do	0.16
Total volume of sample, moist	do	22.56
Temperature of chamber	degrees C	18.2
Total volume of air in chamber and connections to cans, 12263 $\times \frac{733.86}{760} \times \frac{273}{291.2}$	liters, corrected	11,101
Factor		492.06

		H_2O.	CO_2.
In chamber	grams	66.34	51.67
At end of previous subperiod	do	55.83	62.29
Correction	do	+10.51	−10.62

According to the above figures there was contained in the respiration chamber at the end of the subperiod 66.34 grams of water and 51.67 grams of carbon dioxide, while a similar determination at the beginning of the subperiod showed the presence of 55.83 grams of water and 62.29 grams of carbon dioxide. In other words, 10.51 grams of water had accumulated in the chamber during the subperiod and should be added to that actually weighed, while on the contrary the carbon dioxide of the chamber had diminished during the period by 10.62 grams, and this amount should accordingly be subtracted from that actually observed.

The data for all the samples of residual air, somewhat condensed, will be found in Table V of the Appendix.

TOTAL VENTILATION.

The total volume of air passing through the apparatus is measured by the meter pump. As adjusted for this experiment, one stroke is equivalent to 50 liters. The number of strokes during the subperiod is recorded by a revolution counter. The barometric pressure and the temperature of the air as it enters and leaves the pump are recorded every thirty minutes, the average of these readings being taken to represent the average temperature and pressure of the air in the pump. The tension of water vapor in this air is computed from the determination of water in the sample taken.

The following are the results observed during Period C, subperiod 1. In this case the whole of the initial sample of residual air and half of that between the first and second subperiods were taken during the first subperiod, and this volume has to be added, of course, to that measured by the meter pump. On the other hand, the volume of methane generated has to be subtracted from the volume as measured by the pump in order to obtain the actual volume of ingoing air.

Total ventilation.

Meter pump, 9,672 strokes at 50 liters	liters	483, 600
Average temperature	degrees C	13. 58
Average barometer	millimeters	733. 96
Tension of water vapor	do	1. 31
Pressure of air	do	732. 65
483,600 liters $\times \frac{732.65}{760} \times \frac{273}{286.58}$	liters, corrected	444, 105. 36
Sample of residual air, dry	do	33. 55
Total	do	444, 138. 91
Methane generated	do	66. 07
Total ingoing air, dry	do	444, 072. 84

The results for the various periods are contained in Table VI of the Appendix.

INGOING AIR.

As already noted, a continuous sample of the ingoing air was taken by means of an aspirator just at the point of entrance to the chamber. The total volume taken was equal to 200 liters in twelve hours, and the water and carbon dioxide in this sample were absorbed in U tubes containing sulphuric acid and soda lime in the manner already described. In computing the results the air in the aspirator is assumed to be saturated with water vapor.

From the following record of Period C, subperiod 1, it appears that the corrected volume of the sample was 177.05 liters, while the previous table shows the total volume of ingoing air to have been 444,072.84 liters. The factor, therefore, by which the results for water and carbon dioxide must be multiplied to obtain the total amount in the ingoing air is 2,508.02, as shown in the table.

Carbon and hydrogen in ingoing air.

Aspirator reading	liters	200
Temperature	degrees C.	19
Barometer	millimeters	733.86
Tension of water vapor	do	14.42
Pressure of air	do	719.44
$200 \text{ liters} \times \frac{719.44}{760} \times \frac{273}{292}$	liters, corrected	177.00
CO_2 weighed 0.1045 gram×0.50086	do	.05
Total volume of sample, dry	do	177.05
Factor		2,508.2

		H_2O.	CO_2.
In 177.05 liters sample	gram	0.2320	0.1045
In total ventilation	grams	581.9	262.11

A summary of all the results on this point is contained in Table VII of the Appendix.

OUTCOMING AIR.

The meter pump is so constructed as to deliver one stroke out of each 200 to each of two receptacles. In each of these samples water and carbon dioxide are determined, and in one of them a determination is also made of hydrogen and carbon in the form of combustible gases. The results of actual weighing, however, are subject to a correction for the number of strokes of the pump. Thus in the subperiod under consideration the total number of pump strokes, as appears from the previous table, was 9,672, while the record shows that each sample was made up of 48 strokes from the pump. This amount would be one two-hundredth of 9,600 strokes, while in reality there were 72 more, of which no sample was taken. In computing the results it is assumed that the air of these remaining strokes had the average composition of the 9,600 preceding, and the results actually observed are accordingly multiplied by the fraction $\frac{9672}{9600}$. These corrected results are the ones shown in the following table.

To the moisture found in the air coming from the pump must be added the water condensed in the copper cans, and likewise any water condensed upon the cooling pipes carrying the water current, as well as the small amount in the sample of residual air. Finally, the results so obtained have to be corrected for the composition of the residual air in the manner already explained.

The data for Period C, subperiod 1, are contained in the following table, and the corresponding data for the remainder of the experiment are summarized in Tables VIII, IX, and X of the Appendix.

Carbon and hydrogen added in chamber.

	Before ignition.		After ignition.	
	H_2O.	CO_2.	H_2O.	CO_2.
	Grams.	*Grams.*	*Grams.*	*Grams.*
Sample I, corrected	3.2376	12.5741	....	....
Sample II, corrected	3.2416	12.4834	0.5486	0.6498
Sum of samples × 100	647.92	2,505.75	[a] 109.72	[a] 129.96
Water in cans	2,151.00	....	....	....
Drip water	0.00	....	....	....
Water in absorbers	0.00	....	....	....
In residual sample	.18	.18	....	....
Total	2,799.10	2,505.93	....	....
Correction for residual air	+10.51	−10.62	....	....
In outcoming air	2,809.61	2,495.81	109.72	129.96
In ingoing air	581.90	262.11	[b] .50	[b] .79
Added in chamber	2,227.71	2,233.20	109.22	129.18
$H = H_2O \div 9$	247.52	....	12.14	....
$C = CO_2 \times 0.2727$	....	608.99	....	35.23

[a] One sample × 200.

[b] From blank tests, p. 26.

SUMMARY.

The following is a summary of the results obtained for water, carbon dioxide, and hydrocarbons in the several periods:

Carbon and hydrogen excretion.

Period.	Carbon in CO_2.	Hydrogen in H_2O.	Carbon in hydrocarbons.	Hydrogen in hydrocarbons.
	Grams.	*Grams.*	*Grams.*	*Grams.*
Period A:				
Subperiod 1	455.0	201.8	....	....
Subperiod 2	470.3	232.1	28.2	9.6
First day	925.3	433.9	....	....
Subperiod 3	464.5	226.5	28.2	9.4
Subperiod 4	478.3	228.5	27.0	9.3
Second day	942.8	455.0	55.2	18.7
Average	934.1	444.5	55.2	18.7
Period B:				
Subperiod 1	545.6	217.0	32.9	11.0
Subperiod 2	516.6	228.3	34.6	11.4
First day	1,062.2	445.3	67.5	22.4
Subperiod 3	557.4	247.5	39.1	13.0
Subperiod 4	531.6	225.3	34.1	11.5
Second day	1,089.0	472.8	73.2	24.5
Average	1,075.6	459.1	70.4	23.5
Period C:				
Subperiod 1	609.0	247.5	35.2	12.1
Subperiod 2	585.6	241.7	38.9	13.2
First day	1,194.6	489.2	74.1	25.3

Carbon and hydrogen excretion—Continued.

Period.	Carbon in CO_2.	Hydrogen in H_2O.	Carbon in hydrocarbons.	Hydrogen in hydrocarbons.
Period C—Continued.	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Subperiod 3	600.9	251.7	41.9	14.1
Subperiod 4	587.1	264.0	38.4	12.8
Second day	1,188.0	515.7	80.4	26.9
Average	1,191.3	502.5	77.3	26.1
Period D:				
Subperiod 1	646.6	255.2	52.9	17.1
Subperiod 2	642.4	248.1	51.7	16.5
First day	1,289.0	503.3	104.6	33.6
Subperiod 3	651.0	275.2	54.6	17.4
Subperiod 4	640.4	261.4	54.0	17.2
Second day	1,291.4	536.6	108.6	34.6
Average	1,290.2	520.0	106.6	34.1

HYDROCARBON GASES.

In computing the balance of energy it is important to know the nature of the combustible gases given off by the animal in order to be able to compute the amount of potential energy which they contain. The origin of these gases is ascribed to a fermentation of the carbohydrates of the food in the digestive tract, especially in the paunch of ruminants and the cecum of the horse. From the results of laboratory experiments, Tappeiner concluded that the chief products of this fermentation are organic acids, carbon dioxide, methane, and sometimes free hydrogen, and the presence of all these gases, along with more or less nitrogen and oxygen from the air, in the digestive tract has been demonstrated.

In respiration experiments the combustible gases excreted have been commonly assumed to consist of methane, and the amount of the latter has been computed from the amount of oxidizable carbon found by analysis. The writers are not cognizant of any experiments in which the proportions of carbon and hydrogen in the combustible gases normally excreted by herbivora have been determined.

In our experiments, as already noted, both the carbon and hydrogen of the combustible gases were determined. On the extremely probable assumption that they contain no oxygen, a computation of the ratio of hydrogen to carbon furnishes a clew to the nature of the gases. The following table shows this ratio for the several subperiods, as compared with the theoretical ratio for methane:

Ratio of hydrogen to carbon in combustible gases.

Period A:		
Subperiod 2	1:2.906	
Subperiod 3	1:2.949	
Subperiod 4	1:2.881	
		1:2.915

Period B:		
Subperiod 1	1:2.958	
Subperiod 2	1:2.993	1:2.976
Subperiod 3	1:2.986	
Subperiod 4	1:2.922	1:2.954
Period C:		
Subperiod 1	1:2.882	
Subperiod 2	1:2.928	1:2.905
Subperiod 3	1:2.948	
Subperiod 4	1:2.957	1:2.952
Period D:		
Subperiod 1	1:3.058	
Subperiod 2	1:3.095	1:3.076
Subperiod 3	1:3.098	
Subperiod 4	1:3.109	1:3.103
Average		1:2.983
Computed for CH_4		1:2.976

It will be seen that the ratio corresponds so closely to that for methane as to amount very nearly to a demonstration that only this gas was present.

Computed from the amounts of carbon found, the weights of methane excreted in the several subperiods were as follows:

	Grams.
Period A:	
Subperiod 1	......
Subperiod 2	37.58
Subperiod 3	37.66
Subperiod 4	36.12
Average per day (subperiods 3 and 4)	73.78
Period B:	
Subperiod 1	43.99
Subperiod 2	46.16
Subperiod 3	52.23
Subperiod 4	45.50
Average per day	93.94
Period C:	
Subperiod 1	47.06
Subperiod 2	51.93
Subperiod 3	56.02
Subperiod 4	51.31
Average per day	103.16
Period D:	
Subperiod 1	70.69
Subperiod 2	69.01
Subperiod 3	72.92
Subperiod 4	72.07
Average per day	142.35

DETERMINATIONS OF HEAT.

It is impracticable to reproduce here the very voluminous records required for the determination of the heat produced, and it must suffice to indicate the general method and to summarize the main results.

As already explained, the heat given off by the animal as sensible heat is removed from the apparatus in the water current, the amount thus removed being measured by the product of the amount of water passing through the absorbers and the rise in temperature during its passage through the apparatus. As noted, the temperature of the water was taken every four minutes, while the efflux of each 100 liters was noted on the records. In any portion of the experiment during which the rate of flow of water is uniform we may, without sensible error, compute the averages of the ingoing and of the outcoming temperatures and multiply the total weight of water by the difference between the two. Certain corrections are necessary, however.

First. The pipe composing our absorber being of small diameter, there is a not inconsiderable pressure upon the bulbs of the thermometers, and this pressure varies with the rate of flow of the water. Since the pressure is greater upon the ingoing than upon the outcoming thermometer, the effect is to render the observed difference in temperature too small. A correction for this effect was worked out experimentally for the range of pressure used and is applied in the table.

Second. The friction of the water in the absorbers is itself the source of a small amount of heat, which has been computed from the difference in pressure at entrance and exit and the weight of the water passing through the absorbers.

Third. As Atwater and Rosa have shown, it is essential to take account of the variation in the specific heat of water at different temperatures. We have followed their practice, and, assuming the specific heat of water at 20° C. as unity, have expressed all our results in Calories at 20°, using for this purpose the table of the specific heat of water given by those observers.[a]

Fourth. Corrections have to be made for the heat introduced into the apparatus or withdrawn from it in case the feed, drink, excreta, and vessels containing them were introduced or removed at a temperature different from that of the calorimeter. The net amount of these corrections, as appears from the table, is ordinarily small, but the single factors are sometimes not inconsiderable. This is especially the case with the feces, where considerable difficulty was experienced in determining the true average temperature of the mass.

The results of these several computations are contained in Table XI of the Appendix. To the heat thus measured is to be added the latent heat of water vapor produced in and carried out of the chamber. This is computed from the results for water, assuming the latent heat of vaporization to be 0.592 Calorie per gram.

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[a] United States Department of Agriculture, Office of Experiment Stations Bul. No. 63, p. 56.

The following table contains a summary of the amounts of heat measured in the calorimeter in the several periods and subperiods:

Heat measured in calorimeter.

Subperiod.	Heat measured.			
	Period A.	Period B.	Period C.	Period D.
First day:	*Calories.*	*Calories.*	*Calories.*	*Calories.*
Subperiod 1	4,438.8	5,174.0	5,495.0	5,797.7
Subperiod 2	4,787.1	5,348.8	5,414.4	5,709.9
Total	9,225.9	10,522.8	10,909.4	11,507.6
econd day:				
Subperiod 3	4,649.6	5,416.4	5,410.3	5,830.8
Subperiod 4	4,700.6	4,849.9	5,308.8	5,720.5
Total	9,350.2	10,266.3	10,719.1	11.551.3

RATE OF HEAT EMISSION.

The readings of the thermometers, which were taken every four minutes, furnish an approximation to a continuous measurement of the rate at which heat was given off by the animal by radiation and conduction. The individual readings are probably subject to some accidental fluctuations. To eliminate these, each three successive readings have been averaged and multiplied by the amount of water passing through the absorbers during the same twelve minutes. The results, expressed in Calories per minute, are represented graphically on Diagram II, the possible effects of slight variations in the temperature of the calorimeter itself being disregarded.

Aside from minor fluctuations, the most marked variations are those produced by the consumption of water and by the change from the standing to the lying position.

Consumption of water.—It will be noted that in every case the rate at which heat is given off diminishes immediately after the drinking of water and only gradually returns to what may be regarded as its normal rate. Obviously the heat which was produced in the animal was applied in part to raising this water to the temperature of the body, and consequently the rate of emission did not correspond to that of production.

Standing and lying.—The time when the animal stood up or laid down is indicated on the diagram by an arrow. The effect of change of position was very marked and prompt. The heat emission increased rapidly when the animal stood and diminished as promptly when it laid down. This effect has been observed by numerous investigators and naturally ascribed to the increased muscular effort required to maintain the erect posture. In other words, it may be assumed to indicate a difference in the rate of heat production as well as in that of heat emission. The total amount of this difference was considerable. Computed in the same way as the total heat emission, the results for the several periods of standing and lying were as follows, the table referring only to the amount of heat given off by radiation and conduction and removed from the calorimeter in the water current:

Heat emission.

Period and subperiod.	Time.	Position.	Total heat.	Heat per minute.
Period A:				
Subperiod 1—	*Minutes.*		*Calories.*	*Calories.*
6.00 p. m.- 1.38 a. m	458	Standing	2,311.70	5.0474
1.38 a. m.- 6.00 a. m	262	Lying	1,058.49	4.0400
Subperiod 2—				
6.00 a. m.- 6.10 a. m	10	....do	48.87	4.8870
6.10 a. m.- 9.34 a. m	204	Standing	1,109.23	5.437
9.34 a. m.- 2.34 p. m	300	Lying	1,252.79	4.1760
2.34 p. m.- 6.00 p. m	206	Standing	1,118.99	5.4320
Subperiod 3—				
6.00 p. m.- 9.00 p. m	180	....do	911.54	5.0597
9.00 p. m.- 2.46 a. m	346	Lying	1,431.09	4.1361
2.46 a. m.- 6.00 a. m	194	Standing	1,107.87	5.7107
Subperiod 4—				
6.00 a. m.- 7.10 a. m	70	....do	362.00	5.1714
7.10 a. m.-10.46 a. m	216	Lying	897.92	4.1570
10.46 a. m.- 3.18 p. m	272	Standing	1,480.58	5.4433
3.18 p. m.- 5.02 p. m	104	Lying	411.08	3.9522
5.02 p. m.- 6.00 p. m	58	Standing	328.85	5.6698
Period B:				
Subperiod 1—				
6.00 p. m.- 8.54 p. m	174	....do	1,045.70	6.0098
8.54 p. m.-12.06 a. m	192	Lying	914.35	4.7622
12.06 a. m.- 4.42 a. m	276	Standing	1,753.10	6.3518
4.42 a. m.- 6.00 a. m	78	Lying	335.04	4.2954
Subperiod 2—				
6.00 a. m.- 6.02 a. m	2	....do	8.98	4.4900
6.02 a. m.- 9.26 a. m	204	Standing	1,276.59	6.2578
9.26 a. m.- 1.18 p. m	232	Lying	1,021.10	4.4013
1.18 p. m.- 6.00 p. m	282	Standing	1,768.78	6.2722
Subperiod 3—				
6.00 p. m.-11.28 p. m	328	....do	1,892.71	5.7704
11.28 p. m.-12.16 a. m	48	Lying	202.22	4.2129
12.16 a. m.- 6.00 a. m	344	Standing	2,002.49	5.8212
Subperiod 4—				
6.00 a. m.- 9.08 a. m	188	....do	1,069.89	5.6910
9.08 a. m.- 3.14 p. m	366	Lying	1,587.96	4.3414
3.14 p. m.- 6.00 p. m	166	Standing	977.52	5.8887
Period C:				
Subperiod 1—				
6.15 p. m.- 9.26 p. m	191	....do	1,082.21	5.6660
9.26 p. m.- 1.00 a. m	214	Lying	993.79	4.6439
1.00 a. m.- 6.15 a. m	315	Standing	2,095.65	6.6529
Subperiod 2—				
6.15 a. m.- 9.06 a. m	171	....do	1,057.30	6.1830
9.06 a. m.- 1.32 p. m	266	Lying	1,244.56	4.6790
1.32 p. m.- 6.15 p. m	283	Standing	1,799.81	6.3598

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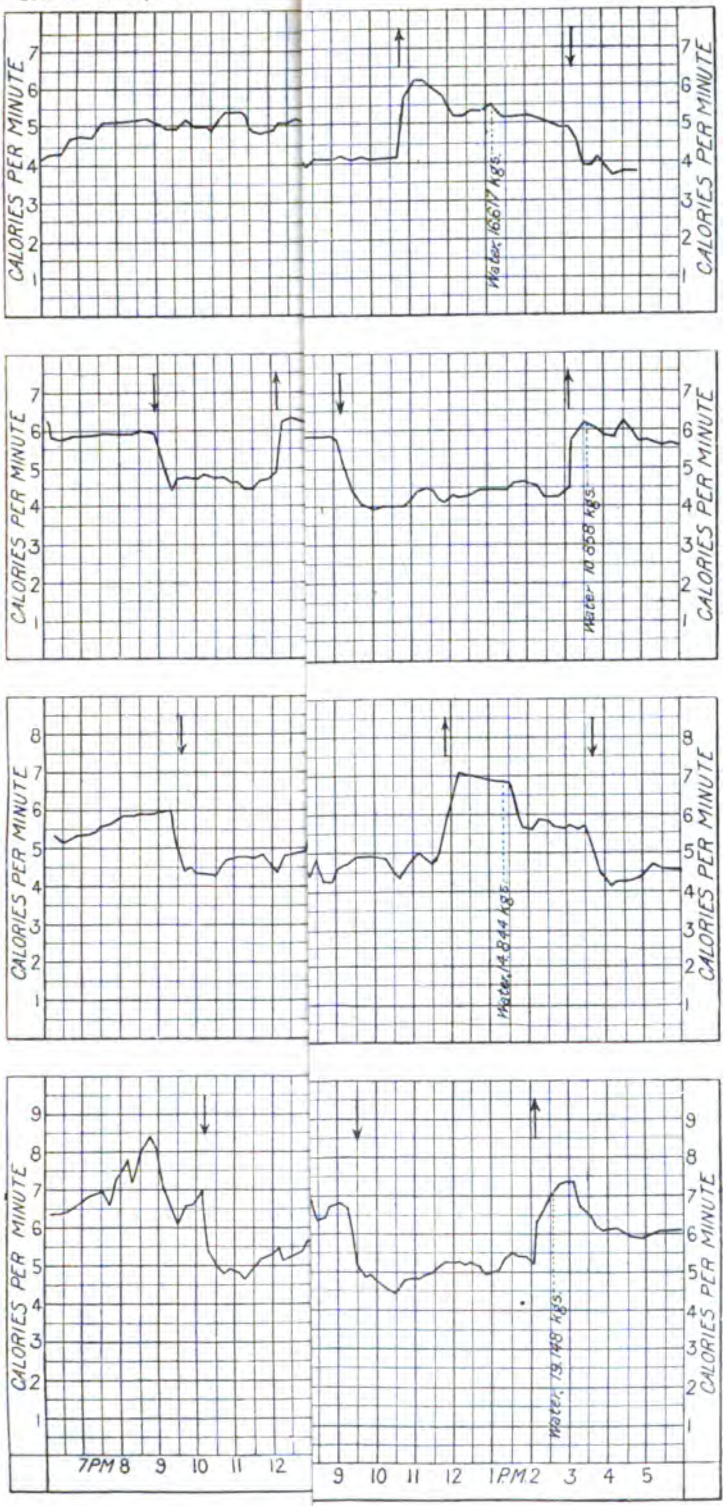
DIAGRAM II.

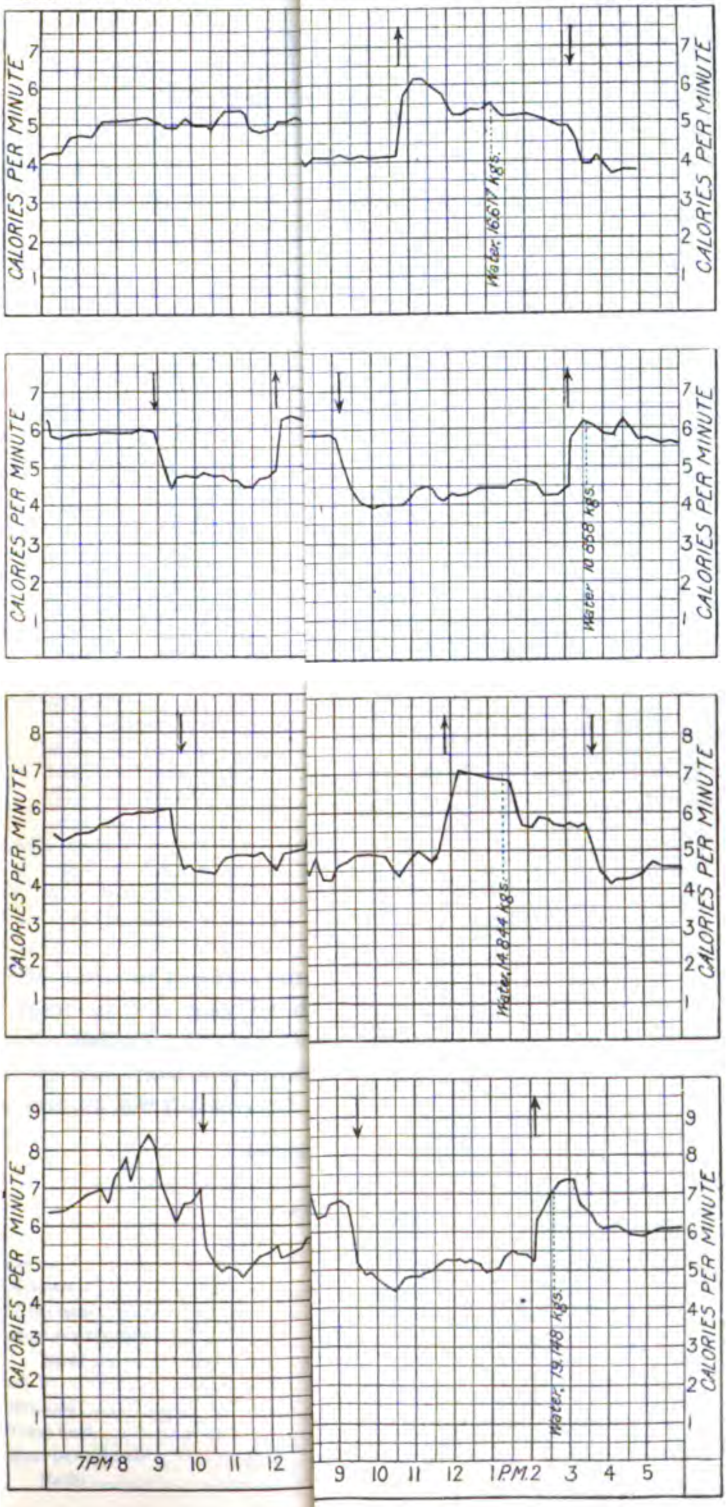


indicate a difference in the rate of heat production as well as in that of heat emission. The total amount of this difference was considerable. Computed in the same way as the total heat emission, the results for the several periods of standing and lying were as follows, the table referring only to the amount of heat given off by radiation and conduction and removed from the calorimeter in the water current:

Heat emission.

Period and subperiod.	Time.	Position.	Total heat.	Heat per minute.
Period A:				
Subperiod 1—	*Minutes.*		*Calories.*	*Calories.*
6.00 p. m.- 1.38 a. m	458	Standing	2,311.70	5.0474
1.38 a. m.- 6.00 a. m	262	Lying	1,058.49	4.0400
Subperiod 2—				
6.00 a. m.- 6.10 a. m	10	.....do	48.87	4.8870
6.10 a. m.- 9.34 a. m	204	Standing	1,109.23	5.437
9.34 a. m.- 2.34 p. m	300	Lying	1,252.79	4.1760
2.34 p. m.- 6.00 p. m	206	Standing	1,118.99	5.4320
Subperiod 3—				
6.00 p. m.- 9.00 p. m	180	.....do	911.54	5.0597
9.00 p. m.- 2.46 a. m	346	Lying	1,431.09	4.1361
2.46 a. m.- 6.00 a. m	194	Standing	1,107.87	5.7107
Subperiod 4—				
6.00 a. m.- 7.10 a. m	70	.....do	362.00	5.1714
7.10 a. m.-10.46 a. m	216	Lying	897.92	4.1570
10.46 a. m.- 3.18 p. m	272	Standing	1,480.58	5.4433
3.18 p. m.- 5.02 p. m	104	Lying	411.08	3.9522
5.02 p. m.- 6.00 p. m	58	Standing	328.85	5.6698
Period B:				
Subperiod 1—				
6.00 p. m.- 8.54 p. m	174	.....do	1,045.70	6.0098
8.54 p. m.-12.06 a. m	192	Lying	914.35	4.7622
12.06 a. m.- 4.42 a. m	276	Standing	1,753.10	6.3518
4.42 a. m.- 6.00 a. m	78	Lying	335.04	4.2954
Subperiod 2—				
6.00 a. m.- 6.02 a. m	2	.....do	8.98	4.4900
6.02 a. m.- 9.26 a. m	204	Standing	1,276.59	6.2578
9.26 a. m.- 1.18 p. m	232	Lying	1,021.10	4.4013
1.18 p. m.- 6.00 p. m	282	Standing	1,768.78	6.2722
Subperiod 3—				
6.00 p. m.-11.28 p. m	328	.....do	1,892.71	5.7704
11.28 p. m.-12.16 a. m	48	Lying	202.22	4.2129
12.16 a. m.- 6.00 a. m	344	Standing	2,002.49	5.8212
Subperiod 4—				
6.00 a. m.- 9.08 a. m	188	.....do	1,069.89	5.6910
9.08 a. m.- 3.14 p. m	366	Lying	1,587.96	4.3414
3.14 p. m.- 6.00 p. m	166	Standing	977.52	5.8887
Period C:				
Subperiod 1—				
6.15 p. m.- 9.26 p. m	191	.....do	1,082.21	5.6660
9.26 p. m.- 1.00 a. m	214	Lying	993.79	4.6439
1.00 a. m.- 6.15 a. m	315	Standing	2,095.65	6.6529
Subperiod 2—				
6.15 a. m.- 9.06 a. m	171	.....do	1,057.30	6.1830
9.06 a. m.- 1.32 p. m	266	Lying	1,244.56	4.6790
1.32 p. m.- 6.15 p. m	283	Standing	1,799.81	6.3598

DIAGRAM II.


CALORIES PER MINUTE
1
2
3
4
5
6
7
8
9
Water, 16.617 kgs.
Water 10.858 kgs.
Water, 14.844 kgs.
Water, 19.148 kgs.
7PM
8
9
10
11
12
9
10
11
12
1P.M.
2
3
4
5

Heat emission—Continued.

Period and subperiod.	Time.	Position.	Total heat.	Heat per minute.
Period C—Continued.				
Subperiod 3—	*Minutes.*		*Calories,*	*Calories.*
6.15 p. m.- 9.42 p. m	207	Standing	1,237.13	5.9764
9.42 p. m.- 3.42 a. m	360	Lying	1,791.27	4.9755
3.42 a. m.- 6.15 a. m	153	Standing	1,047.10	6.8438
Subperiod 4—				
6.15 a. m.- 7.42 a. m	87	.....do	571.79	6.5723
7.42 a. m.-11.50 a. m	248	Lying	1,183.33	4.7715
11.50 a. m.- 3.38 p. m	228	Standing	1,431.22	6.2772
3.38 p. m.- 6.15 p. m	157	Lying	702.80	4.4764
Period D:				
Subperiod 1—				
6.00 p. m.-10.12 p. m	252	Standing	1,713.90	6.8011
10.12 p. m.- 1.44 a. m	212	Lying	1,110.29	5.2372
1.44 a. m.- 4.04 a. m	140	Standing	806.18	5.7584
4.04 a. m.- 5.22 a. m	82	Lying	519.45	6.3348
5.22 a. m.- 6.00 a. m	34	Standing	294.01	8.6473
Subperiod 2—				
6.00 a. m.- 9.36 a m	216	.....do	1,495.85	6.9252
9.36 a. m.-12.30 p. m	174	Lying	889.19	5.1103
12.30 p. m.- 3.22 p. m	172	Standing	1,109.46	6.4503
3.22 p. m.- 5.18 p. m	116	Lying	487.07	4.1989
5.18 p. m.- 6.00 p. m	42	Standing	260.18	6.1948
Subperiod 3—				
6.00 p. m.-10.10 p. m	250	.....do	1,597.64	6.3905
10.10 p. m.- 1.10 a. m	180	Lying	911.21	5.0623
1.10 a. m.- 2.36 a. m	86	Standing	607.46	7.0634
2.36 a. m.- 4.10 a. m	94	Lying	490.35	5.2165
4.10 a. m.- 6.00 a. m	110	Standing	750.03	6.8184
Subperiod 4—				
6.00 a. m.- 9.26 a. m	206	.....do	1,368.14	6.6413
9.26 a. m.- 2.12 p. m	286	Lying	1,455.33	5.0886
2.12 p. m.- 6.00 p. m	228	Standing	1,449.62	6.3580

The value of results computed from determinations extending over an hour or less may be doubted. If we take for each period the determinations covering three hours or more, disregarding the artificial division into subperiods, we have for the average heat emission per minute for the several periods the figures of the following table:

Average heat emission per minute.

Period.	Lying.	Standing.
Period A:		
Minutes ....number..	1,134	1,584
Total heat ....Calories..	4,689.2	8,401.9
Heat per minute ....do....	4.135	5.304
Ratio ....do....	1	1.283
Period B:		
Minutes ....number..	790	1,622
Total heat ....Calories..	3,523.4	9,763.6
Heat per minute ....do....	4.460	6.019
Ratio ....do....	1	1.349

Average heat emission per minute—Continued.

Period.		Lying.	Standing.
Period C:			
Minutes	number..	1,068	1,635
Total heat	Calories..	5,213.0	10,322.2
Heat per minute	do....	4.791	6.313
Ratio	do....	1	1.318
Period D:			
Minutes	number..	678	1,338
Total heat	Calories..	3,476.8	8,929.4
Heat per minute	do....	5.128	6.673
Ratio	do....	1	1.301

The figures of the above table relate only to the amount of heat brought out by the water current—that is, to the heat given off by radiation and conduction. No similar measurement could be made of the heat removed as latent heat of water vapor, which constituted approximately one-fourth of the total quantity given off, but if we assume that it increased and decreased in proportion to the heat brought out by the water current we can readily compute its amount. This hypothesis may be regarded as one extreme, the other being the hypothesis that the amount of heat carried off as latent heat of water vapor was unaffected by the posture of the animal.

The following table shows the amount of heat measured in the water current and the amount of heat carried out of the calorimeter as latent heat of water vapor in the several subperiods. In this table the corrections for food, excreta, etc., are made in the heat carried off by the water current.

Heat in water current and latent heat of water vapor.

Period and subperiod.	Time passed standing.	Heat measured in water current.	Heat as latent heat of water vapor.	Per cent of total heat removed in water vapor.
Period A:	*Per cent.*	*Calories.*	*Calories.*	*Per cent.*
Subperiod 1	63.62	3,363.9	1,074.9	24.21
Subperiod 2	56.95	3,550.5	1,236.6	25.83
Subperiod 3	51.95	3,443.0	1,206.7	25.95
Subperiod 4	55.56	3,483.3	1,217.3	25.90
Average per day	57.02	6,920.3	2,367.8	25.49
Period B:				
Subperiod 1	62.50	4,017.5	1,156.5	22.35
Subperiod 2	67.50	4,132.8	1,216.1	22.73
Subperiod 3	93.33	4,097.9	1,318.4	24.34
Subperiod 4	49.17	3,649.7	1,200.2	24.75
Average per day	68.13	7,949.0	2,445.6	23.53

Heat in water current and latent heat of water vapor—Continued.

Period and subperiod.	Time passed standing.	Heat measured in water current.	Heat as latent heat of water vapor.	Per cent of total heat removed in water vapor.
	Per cent.	*Calories.*	*Calories.*	*Per cent.*
Period C:				
Subperiod 1	70.28	4,176.2	1,318.8	24.00
Subperiod 2	63.06	4,126.5	1,287.9	23.79
Subperiod 3	50.00	4,069.1	1,341.1	24.79
Subperiod 4	43.75	3,902.1	1,406.8	26.56
Average per day	56.77	8,137.0	2,677.3	24.76
Period D:				
Subperiod 1	59.17	4,438.2	1,359.5	23.45
Subperiod 2	59.73	4,388.1	1,321.8	23.15
Subperiod 3	61.95	4,364.4	1,466.4	25.15
Subperiod 4	60.28	4,327.9	1,392.6	24.34
Average per day	60.28	8,759.3	2,770.2	24.08

As the foregoing table shows, there were considerable variations in the time spent standing and lying in the several periods—a fact which would necessarily tend to vitiate to some extent a comparison of the results. This we can to a degree eliminate by computing on the above two hypotheses the amount of heat which would have been produced had the animal stood or laid down during the whole experiment. Thus in Period A the average amount of heat brought out in the water current was, while lying, 4.135 Calories per minute; while standing, 5.304 Calories per minute. Multiplying these figures by 1,440 gives the total amount of heat given off by radiation and conduction in twenty-four hours, namely, while lying, 5,955 Calories; while standing, 7,638 Calories. In this period, however, as appears in the last table, the heat given off by radiation and conduction constituted 74.51 per cent of the total heat given off. Dividing by this factor we have, on the first hypothesis, for the total computed heat production, lying, 7,993 Calories; standing, 10,250 Calories.

Upon the second hypothesis we should simply add the amount of heat actually measured as latent heat of water vapor to the amount of heat brought out in the water current as computed above, making the totals, respectively, for lying, 8,323 Calories; for standing, 10,006 Calories. The following table contains the results computed upon both of the above hypotheses, as compared with the results actually observed:

Heat emission.

Period.	Observed.	Computed lying.		Computed standing.	
		First hypothesis.	Second hypothesis.	First hypothesis.	Second hypothesis.
	Calories.	*Calories.*	*Calories.*	*Calories.*	*Calories.*
A	9,288	7,993	8,323	10,251	10,006
B	10,395	8,399	8,869	11,334	11,114
C	10,814	9,170	9,576	12,083	11,769
D	11,529	9,722	10,154	12,650	12,380

HEAT EMISSION AND HEAT PRODUCTION.

The figures of the above tables show the amounts of heat given off by the animal. The heat emitted by the animal, however, is equivalent to the amount of heat actually produced only when the initial and final states of the animal are the same. Consequently there may be, according to circumstances, either a storage of heat in the body or an emission of heat produced in a previous period. In this respect there are two principal sources of error: First, variations in the body temperature of the animal, and, second, a storage or loss of matter in the body. As regards the first of these sources of error, it has been assumed that under normal and uniform conditions the body temperature would be substantially the same at the same hour of the day. We have not been able as yet to make systematic determinations of the body temperature of cattle as a check upon this assumption. That the body temperature may be affected in particular by the consumption of water is rendered probable by the observations upon the rate of heat emission just considered. It is evident that for a time after drinking, the average temperature of the animal plus the water drunk must be somewhat reduced, and our results upon the rate of heat emission strongly suggest that this effect may continue for a considerable time. Our animal was watered less than five hours before leaving the calorimeter and it seems possible that his body temperature was not fully restored to the normal by this time, particularly in Periods C and D.

If the animal stores up matter in its body, there must necessarily be a corresponding storing up of heat, since the matter which is stored was consumed in the food at a temperature considerably below that of the body. On the other hand, if there is a loss of matter from the body in any one of the various excreta, the temperature of this matter is reduced (either actually or by calculation) to that of the surrounding air before it leaves the calorimeter, and this heat which was previously stored up in the body is measured along with that actually produced during the experiment. The above statements are, of course, true, whatever be the kind of matter stored up or given off, but the income and outgo of water is of especial importance in this respect, both because of its large amount and because of the high specific heat of water. Indeed, a very simple calculation serves to show that in these experiments the difference in the income and outgo of dry matter does not materially affect the computation of the balance of energy, and that consequently only the income and outgo of water need be considered.

From the data contained in the various tables of the Appendix is compiled the following table, showing the income and outgo of water by the animal and the consequent gain or loss of heat on each day of the calorimeter experiments. As regards the urine the figures are approximate only. The dry matter was not determined, but its amount has been computed on the assumption that it is proportional to the specific gravity. The body temperature has been assumed to be 38.5° C., while that of the calorimeter in every case was 18.2° C. In the case of feces spilled in the calorimeter the water remaining in them when sampled has been divided equally between the two days. The amount of urine spilled has been calculated to the fresh weight upon the basis of its nitrogen content:

Approximate water balance.

Period.	Income.	Outgo.
Period A:		
April 2—	*Grams.*	*Grams.*
Hay	371	....
Linseed meal	42	....
Water	1,952	....
Feces	....	4,913
Urine	....	3,530
Water vapor	....	3,905
Balance	9,983	....
	12,348	12,348
April 3—		
Hay	371	....
Linseed meal	42	....
Water	16,617	....
Feces	....	5,692
Urine	....	4,563
Water vapor	....	4,094
Balance	....	2,681
	17,030	17,030
Period B:		
March 5—		
Hay	513	....
Linseed meal	45	....
Water	9,486	....
Feces	....	8,364
Urine	....	3,073
Water vapor	....	4,008
Balance	5,401	....
	15,445	15,445
March 6—		
Hay	513	....
Linseed meal	45	....
Water	10,630	....
Feces	....	8,712
Urine	....	2,514
Water vapor	....	4,254
Balance	4,292	....
	15,480	15,480

Approximate water balance—Continued.

Period.	Income.	Outgo.
Period C:		
March 19—	*Grams.*	*Grams.*
Hay	626	
Linseed meal	44	
Water	15,335	
Feces		10,774
Urine		3,280
Water vapor		4,403
Balance	2,452	
	18,457	18,457
March 20—		
Hay	626	
Linseed meal	44	
Water	14,844	
Feces		11,620
Urine		3,235
Water vapor		4,642
Balance	3,983	
	19,497	19,497
Period D:		
April 16—		
Hay	914	
Linseed meal	46	
Water	20,086	
Feces		14,324
Urine		4,499
Water vapor		4,529
Balance	2,306	
	23,352	23,352
April 17—		
Hay	914	
Linseed meal	46	
Water	19,148	
Feces		12,466
Urine		4,117
Water vapor		4,829
Balance	1,304	
	21,412	21,412

Upon the basis of the above figures the actual heat production has been computed as shown in the following table, the difference between the income and outgo of water, expressed in kilograms, being multiplied by 20.3, the difference in temperature, to obtain the correction:

Heat production.

Period.	Measured in calorimeter.	Correction for water.	Heat produced.
	Calories.	*Calories.*	*Calories.*
Period A:			
First day	9,225.9	−200.6	9,025.3
Second day	9,350.2	+ 54.4	9,404.6
Average	....	....	9,215.0
Period B:			
First day	10,522.8	−109.6	10,413.2
Second day	10,266.3	− 87.1	10,179.2
Average	....	....	10,296.2
Period C:			
First day	10,909.4	− 49.8	10,859.6
Second day	10,719.1	− 80.9	10,638.2
Average	....	....	10,748.9
Period D:			
First day	11,507.6	− 46.8	11,460.8
Second day	11,551.3	− 26.5	11,524.8
Average	....	....	11,492.8

Making the same average corrections in the results as computed on page 39 for the standing and lying positions, we have the following as the final averages for the heat production:

Averages for heat production.

Period.	Observed.	Computed lying.		Computed standing.	
		First hypothesis.	Second hypothesis.	First hypothesis.	Second hypothesis.
	Calories.	*Calories.*	*Calories.*	*Calories.*	*Calories.*
A	9,215	7,920	8,250	10,178	9,933
B	10,296	8,300	8,770	11,235	11,015
C	10,749	9,105	9,511	12,018	11,704
D	11,493	9,686	10,118	12,614	12,344

THE BALANCE OF MATTER.

Considering the figures for epidermal tissues on page 23 to represent the average rate of growth of hair, etc., we may subdivide the gain or loss as ordinarily computed into the growth of these tissues and the real gain or loss of the proteids and fat in the body, as has been done in the computations which follow:

THE NITROGEN AND CARBON BALANCE.

The income and outgo of nitrogen and carbon are shown in the following table. The figures for hydrogen are omitted for the reason that, as explained on page 24, the results for water were not found to be satisfactory:

Income and outgo of nitrogen and carbon per day and head.

Period.	Nitrogen.		Carbon.	
	Income.	Outgo.	Income.	Outgo.
Period A:	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Hay	23.4		1,337.6	
Linseed meal	22.2		172.5	
Feces		16.2		649.8
Urine		36.3		88.1
Carbon dioxide				934.1
Hydrocarbons				55.2
Epidermal tissue		1.3		8.0
Balance	8.2		225.1	
	53.8	53.8	1,735.2	1,735.2
Period B:				
Hay	32.5		1,876.8	
Linseed meal	22.1		170.7	
Feces		20.8		858.0
Urine		33.7		101.3
Carbon dioxide				1,075.6
Hydrocarbons				70.4
Epidermal tissue		1.3		8.0
Balance	1.2		65.8	
	55.8	55.8	2,113.3	2,113.3
Period C:				
Hay	40.6		2,366.9	
Linseed meal	21.8		172.5	
Feces		27.4		1,146.1
Urine		34.1		117.6
Carbon dioxide				1,191.3
Hydrocarbons				77.3
Epidermal tissue		1.3		8.0
Balance	.4		.9	
	62.8	62.8	2,539.4	2,539.4
Period D:				
Hay	56.4		2,831.7	
Linseed meal	21.9		172.6	
Feces		33.5		1,428.7
Urine		32.4		124.2
Carbon dioxide				1,290.2
Hydrocarbons				106.6
Epidermal tissue		1.3		8.0
Balance		11.1		46.7
	78.3	78.3	3,004.3	3,004.3

GAIN OR LOSS OF PROTEIN AND FAT.

Excluding the amount of epidermal tissue produced, the gain or loss of protein and fat has been computed in the usual manner, using Köhler's[a] figures for the composition of the nitrogenous tissue of cattle, namely, nitrogen 16.67 per cent and carbon 52.54 per cent. In other words, body protein is equivalent to nitrogen multiplied by 6. In the computation of fat from carbon the usual factor (1.3) has been employed.

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[a] Zeit. physiol. Chem., v. 31, p. 479.

Gain or loss of protein and fat per day and per head.

Period.	Gain of nitrogen.	Equivalent protein (N×6).	Gain of carbon.			Equivalent gain of fat.
			Total.	As protein.	As fat.	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
A	− 8.2	−49.2	−225.1	−25.9	−199.2	−259.0
B	− 1.2	− 7.2	− 65.8	− 3.8	− 62.0	− 80.6
C	− .4	− 2.4	− .9	− 1.3	+ .4	+ .5
D	+11.1	+66.6	+ 46.7	+35.0	+ 11.7	+ 15.2

THE BALANCE OF ENERGY.

In these experiments we have direct determinations of all the factors of income and outgo of energy, except the potential energy of the methane excreted and that of the tissue gained by the animal. The energy of the methane, however, may be safely computed from its amount, its heat of combustion at constant pressure being 13.344 Calories per gram. The energy of the gain of tissue by the animal may be estimated in the usual way from the computed amounts of protein and fat given above, using the factors 5.7 Calories and 9.5 Calories per gram, respectively. Having done this, we are in position to compare the income with the outgo of energy, and thus to check to a certain extent the accuracy of our experiments. The following table contains such a comparison for each period. The difference between income and outgo, which has been entered in the table under the heading "Error," shows, of course, the extent to which our results appear to deviate from those required by the law of the conservation of energy:

Balance of energy per day and per head.

Period.	Income.	Outgo.
Period A:	*Calories.*	*Calories.*
Hay	13,035	....
Linseed meal	1,824	....
Feces	....	6,432
Urine	....	853
Methane	....	984
Epithelial growth	....	88
Heat	....	9,215
Loss by body—		
Protein	280	....
Fat	2,461	....
Error	....	28
	17,600	17,600

Balance of energy per day and per head—Continued.

Period.	Income.	Outgo.
Period B:	*Calories.*	*Calories.*
Hay	18,463	
Linseed meal	1,811	
Feces		8,574
Urine		965
Methane		1,253
Epithelial growth		88
Heat		10,296
Loss by body—		
Protein	41	
Fat	766	
Error	95	
	21,176	21,176
Period C:		
Hay	23,321	
Linseed meal	1,814	
Feces		11,456
Urine		1,110
Methane		1,374
Epithelial growth		88
Heat		10,749
Loss by body (protein)	14	
Gain by body (fat)		5
Error		367
	25,149	25,149
Period D:		
Hay	27,727	
Linseed meal	1,811	
Feces		14,243
Urine		1,210
Methane		1,896
Epithelial growth		88
Heat		11,493
Gain by body—		
Protein		380
Fat		144
Error		84
	29,538	29,538

Except in Period C, the discrepancy in the results is relatively small and may very well be ascribed in part to the uncertainties involved in the method of computing the energy of tissue gained or lost.

Comparing the heat production actually observed with that computed in the usual way by subtracting the energy of the excreta plus gain from the energy of the food, we have the following:

Heat production per day.

Period.	Computed.	Observed.	Computed ÷ observed.
	Calories.	*Calories.*	
A	9,243	9,215	100.3
B	10,201	10,296	99.1
C	11,116	10,749	103.4
D	11,577	11,493	100.7

Only in Period C does the difference reach 1 per cent of the total amount of heat measured.

DISCUSSION OF RESULTS.

THE DIGESTIBILITY OF THE RATIONS.

Bringing together the results tabulated in Table III of the Appendix and summarized also under the several periods, we have the following figures for the percentage digestibility of the total ration for the several periods:

Percentage digestibility.

Constituents and energy.	Period A.	Period B.	Period C.	Period D.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Dry matter	58.69	60.23	57.05	54.22
Ash	45.14	46.60	43.96	40.22
Organic matter	59.36	60.89	57.68	54.92
Proteids	59.19	57.15	51.27	51.75
Nonproteids[a]	[100.00]	[100.00]	[100.00]	[100.00]
Crude fiber	56.17	60.94	55.89	51.74
Nitrogen-free extract	60.80	61.04	59.53	57.06
Ether extract	66.80	61.28	58.19	59.93
Energy	56.71	57.76	54.42	51.78

[a] Assumed.

Periods B, C, and D show a decrease in the percentage digestibility as the amount of the ration and the proportion of hay was increased. Period A, however, on the lightest ration and with the smallest proportion of hay, is an exception to this rule, the digestibility being somewhat lower than in Period B. It will be recalled that this period followed in order of time Period C—that is, a period in which a considerably larger ration was fed. It is not impossible that the apparently lower digestibility in Period A may arise from the fact that the animal had not quite come into equilibrium with the new ration, but was still excreting too large an amount of feces. This supposition is, to some extent, supported by the figures for the live weight of the animal as represented on Diagram I, from which it seems that the weight of the animal on the first two days of the experiment had not reached its lowest point.

Taking the figures for the organic matter as affording the most satisfactory measure of variations in digestibility, we find that the decrease in digestibility in Periods B, C, and D is very regular. Undoubtedly this is due in part to the larger proportion of hay as compared with linseed meal, but with the comparatively small amount of the latter fed (5.5 to 11.1 per cent of the dry matter of the ration) no great difference could be caused in this way. If we assume for the percentage digestibility of linseed meal the figures reported by Lindsey,[a] namely—

	Per cent.
Dry matter	78.7
Organic matter	81.2
Protein	88.8
Crude fiber	57.0
Nitrogen-free extract	77.6
Ether extract	88.6

we can compute the probable percentage digestibility of the hay itself in the several periods with the following results:

Computed digestibility of hay.

Constituents.	Period A.	Period B.	Period C.	Period D.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Dry matter	56.20	58.60	55.54	52.80
Organic matter	57.02	58.79	56.15	53.39
Proteids	35.02	38.96	34.39	39.54
Nonproteids [a]	[100.00]	[100.00]	[100.00]	[100.00]
Crude fiber	56.15	61.02	55.86	51.56
Nitrogen-free extract	59.04	59.79	58.47	56.03
Ether extract	54.08	50.55	48.38	53.26

[a] Assumed.

After substantially eliminating in this way the effects of the varying proportion of linseed meal, we find that the digestibility of the hay for Periods B, C, and D shows a regular decrease. On the other hand, if we make the calculation in the reverse way, by using the figures obtained in the preliminary period to represent the digestibility of the hay and computing from these the digestibility of linseed meal for the several periods, we get exceedingly divergent and, in one case, impossible results, the computed percentages for organic matter being—

	Per cent.		Per cent.
Period A	75.55	Period C	62.32
Period B	101.10	Period D	12.58

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[a] Massachusetts Experiment Station, Report 1893, pp. 169–173.

It seems clear, then, that in these experiments, contrary to the generally accepted view, the digestibility of the hay decreased sensibly as the amount fed increased.

METABOLIZABLE ENERGY.

A certain proportion of the total or gross energy of the food consumed by an animal escapes from the body as the potential energy of the various excreta, while the remainder is, or is capable of being, converted into the kinetic form in the body. Since this latter portion alone can be considered to be of any direct use to the animal, the term available energy or, more specifically, gross available energy, has been applied to it. As one of us has recently pointed out,[a] however, and as will appear in the further discussion of these results, there are not wanting indications that a portion of this so-called available energy may in some instances be of no direct use to the organism; that is, it may neither serve immediately to maintain the vital processes nor add to the store of potential energy in the body, but simply increase the heat production of the animal. We therefore venture to propose the substitution for the term "gross available energy" of the term "metabolizable energy" as equivalent to energy of food minus energy of excreta. Although not particularly euphonious, this term has the advantage of expressing the facts of the case while avoiding any implications regarding the uses to which this energy is put in the body as well as the necessity of using the word "available" in two senses.

The data of the foregoing pages enable us to compute the metabolizable energy of the rations in the several periods. Before doing so, however, a certain correction is necessary in the energy of the urine. For example, in Period A the animal lost 8.2 grams of body nitrogen, corresponding to a loss of 49.2 grams of protein. According to Rubner's results, the potential energy of the urine is increased by 7.45 Calories for each gram of urinary nitrogen coming from the oxidation of body protein. In this case, then, the urine contained $8.2 \times 7.45 = 61$ Calories of energy not derived from the potential energy of the food but from that of body tissue. It is plain, then, that the potential energy of the urine must be diminished by this amount before it is subtracted from the gross energy of the food in order to get the true metabolizable energy of the latter. The corresponding corrections for the several periods, computed in this way, are as follows:

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[a] Armsby: Principles of Animal Nutrition, Chap. XII.

Corrected energy of urine.

Period.	Gain of nitrogen.	Equivalent energy.	Corrected energy of urine.
	Grams.	*Calories.*	*Calories.*
A	− 8.2	−61	792
B	− 1.2	− 9	956
C	− .4	− 3	1,107
D	+11.1	+83	1,293

Using these corrected figures, the metabolizable energy of the total ration for the several periods was as follows:

Metabolizable energy of the total ration.

Feed and excreta.	Period A.		Period B.		Period C.		Period D.	
	Feed.	Excreta.	Feed.	Excreta.	Feed.	Excreta.	Feed.	Excreta.
	Calories.	*Calories.*	*Calories.*	*Calories.*	*Calories.*	*Calories.*	*Calories.*	*Calories.*
Hay	13,035	....	18,463	....	23,321	....	27,727	....
Linseed meal	1,824	....	1,811	....	1,814	....	1,811	....
Feces	....	6,432	....	8,574	....	11,456	....	14,243
Urine (corrected)	....	792	....	956	....	1,107	....	1,293
Methane	....	984	....	1,253	....	1,374	....	1,896
Metabolizable	....	6,651	....	9,491	....	11,198	....	12,106
Total	14,859	14,859	20,274	20,274	25,135	25,135	29,538	29,538

The relation of metabolizable energy to the amount of matter in the food may be expressed as Calories per gram of the total or of the digested organic matter, with the following results:

Metabolizable energy per gram of organic matter.

Period.	Organic matter of rations.		Metabolizable energy.		
	Total.	Digested.	Total.	Per gram of total organic matter.	Per gram of digested organic matter.
	Grams.	*Grams.*	*Calories.*	*Calories.*	*Calories.*
A	3,085	1,831	6,651	2.156	3.633
B	4,171	2,540	9,491	2.275	3.736
C	5,225	3,014	11,198	2.143	3.716
D	6,137	3,370	12,106	1.972	3.592

It is of interest also to compute the proportion of the potential energy of the food which was metabolizable. This likewise may be computed upon the gross energy of the total ration or upon the energy of the apparently digested matter, with the results shown in the following table. These percentages are, in a sense, comparable with digestion coefficients; that is to say, they show what percentage of the gross energy of the total or of the digested matter, respectively, was capable of conversion into the kinetic form:

Percentage of total energy metabolized.

Period.	Gross energy.		Metabolizable energy.	Percentage metabolizable.	
	Total.	Of digested matter.		Of total energy.	Of energy of digested matter.
	Calories.	*Calories.*	*Calories.*	*Per cent.*	*Per cent.*
A	14,859	8,427	6,651	44.76	78.93
B	20,274	11,700	9,491	46.81	81.12
C	25,135	13,679	11,198	44.56	81.87
D	29,538	15,295	12,106	40.98	79.14

It appears that the percentage of the total energy of the food which was metabolized diminished as the amount of the ration increased, as was the case with the percentage digestibility. On the other hand, the percentages computed upon the energy of the digested matter are fairly uniform, thus showing that in these experiments the chief factor affecting the percentage of energy metabolizable was the digestibility of the rations—that is, the loss in the feces.

As already noted, the lower figures for digestibility in Period A may perhaps be attributed to excessive excretion, due to the previous heavier ration. If we assume that the true percentage metabolizable for Period A was 47 instead of 44.76, as computed, then the total metabolizable energy for that period would be 6,979 Calories instead of 6,651 Calories. This corrected figure we shall have occasion to use tentatively later.

The above figures, of course, all apply to the total rations of the several periods, the experiment affording no sufficient data for computing separately the metabolizable energy of the hay and of the linseed meal. We can, however, make an approximate computation by difference. The amount of linseed meal fed having been the same for the several periods, if we take the ration of Period A as a basal ration and subtract the results from those in the other periods, the difference will represent the effect of the added hay. In so doing, however, we virtually ascribe all the difference in the digestibility of the hay in the several periods to the relatively small amount added, and as a natural result the percentage of energy metabolized appears to diminish rapidly, as appears in the table on the next page.

Computed metabolizable energy of hay.

Period.	Gross energy.		Metabolizable energy.	Percentage metabolizable.	
	Total.	Of digested matter.		Of total energy.	Of energy of digested matter.
	Calories.	*Calories.*	*Calories.*	*Per cent.*	*Per cent.*
B	20,274	11,700	9,491	....	....
A	14,859	8,427	6,651	....	....
Difference	5,415	3,273	2,840	52.45	86.77
C	25,135	13,679	11,198	....	....
A	14,859	8,427	6,651	....	....
Difference	10,276	5,252	4,547	44.25	85.58
D	29,538	15,295	12,106	....	....
A	14,859	8,427	6,651	....	....
Difference	14,679	6,868	5,455	37.16	79.42

The computation upon the energy of the digested matter, as before, largely eliminates the differences between the several periods. The falling off in the last case in the table arises chiefly from an unusually large excretion of methane in Period D, as appears clearly in the following table, showing the distribution of the energy of the digested matter:

Distribution of energy of digested matter.

Period.	In urine.	In methane.	Metabolizable.
	Per cent.	*Per cent.*	*Per cent.*
A	9.40	11.68	78.92
B	8.17	10.71	81.12
C	8.09	10.04	81.87
D	8.45	12.41	79.14

As compared with Kellner's well-known results upon coarse fodders,[a] these figures show that the percentage of the total (gross) energy of the hay which was metabolized was apparently somewhat less than was found by that investigator for meadow hay. On the other hand, when computed upon the digestible matter only, our percentage is somewhat greater than Kellner's, a result due in part to the somewhat smaller loss of energy in the urine.

NET AVAILABILITY.

Numerous experimenters have shown that when food is supplied to a previously fasting animal the metabolism and consequent heat production is usually increased. This increased heat production is commonly ascribed to an expenditure of energy in the processes of digestion, including mastication, and in the chemical changes incident to the conversion of the digested material into such forms as are fitted to sustain the physiological processes of the body. The energy thus expended has been briefly designated as the work of digestion and assimilation. This energy ultimately takes the form of heat, in which form it is of no direct use to the body, although it appears under some circumstances to be of indirect use in maintaining the body temperature and thus preventing the consumption of tissue for that purpose. It is obvious, then, that unless this compensation takes place the energy expended in digestion and assimilation is waste energy so far as relates to maintenance or production of body tissue, and that only that portion of the metabolizable energy of the food which remains after the work of digestion and assimilation has been accomplished is capable of serving the general physiological uses of the organism. The portion of the metabolizable energy remaining after deducting the work of digestion and assimilation has been designated as available energy, or, more specifically, as net available energy, to distinguish it from what has been called gross available energy, equivalent to the term metabolizable energy as here used.

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[a] Landw. Vers.-Stat., v. 53.

It is obvious that if we can determine the metabolism of an animal in the fasting state and also after the consumption of a known amount of food, we can determine the available energy of the latter by subtracting from its metabolizable energy the increase in the heat production of the animal. In the case of ruminants, however, it is impracticable, for obvious reasons, to determine satisfactorily the fasting metabolism. The determination of the available energy of a feeding stuff, however, may be equally well, although a little less simply, made by adding the substance in question to a known basal ration and determining the increase of heat production or, what amounts to the same thing, the extent to which the added food diminishes the previous loss of tissue. In other words, the availability can be determined by a computation by difference between two rations less than the maintenance ration in substantially the same way that Kellner has employed to determine the production value above the maintenance ration. In the former case the difference in the loss of tissue on the two rations will represent the amount of available energy in the added food, since it shows the extent to which the latter has been able to take the place of tissue previously oxidized.

Such a comparison can, of course, be based either upon the total energy of the food, the energy of the digested matter, or upon the metabolizable energy. Since, however, the latter represents the amount of energy actually put at the disposal of the organism, it seems the proper basis upon which to make the comparison with a view to discovering the general laws governing availability, and this method has been followed.

As the balance of energy on page 45 shows, however, the gain or loss as computed from the nitrogen and carbon balance does not exactly agree with that computed from the difference between ingo and outcome of energy. For the present purpose it seems most satisfactory to use the average of these results or, in other words, to substitute in the balance of energy on page 45 the average of the computed and the observed heat production as given on page 47. Thus, in Period A, we obtain the following as the average loss of energy in the form of protein and fat:

Average loss of energy.

Feed, excreta, etc.	Income.	Outgo.
	Calories.	*Calories.*
Hay	13,035	....
Linseed meal	1,824	....
Feces	....	6,432
Urine, corrected	....	853
Methane	....	981
Epithelial tissue	....	88
Average heat production	....	9,229
Computed loss of protein and fat	2,727	....
Total	17,586	17,586

In making the comparison with the metabolizable energy, however, the loss of tissue as thus computed must be corrected by subtracting 7.45 Calories for each gram of nitrogen in the urine, since the amount of metabolizable energy was corrected in the same way. The average figures for the growth of epithelial tissue must also be counted as part of the gain. Making these corrections we have the following results for the several periods, those for Period C being computed both on the basis of the observed and of the computed heat production instead of upon the average, as in the other cases:

Average gain or loss.

Period.	Average gain or loss of protein and fat.	Growth of epithelial tissue.	Correction for nitrogen.	Total gain or loss.
	Calories.	*Calories.*	*Calories.*	*Calories.*
A	−2,727	+88	+61	−2,578
B	− 855	+88	+ 9	− 758
C, based on observed heat production	+ 358	+88	+ 3	+ 449
C, based on computed heat production	− 9	+88	+ 3	+ 82
C (average)	....	....	....	+ 266
D	+ 566	+88	−8 3	+ 571

From the computed heat production standing and lying we can compute in the same way the gain or loss of tissue in the two positions.

Since, however, we have no determinations of the carbon and nitrogen balance in the two positions of the animal these computations must, of course, be based upon the heat production as directly measured. If, then, we substitute in the balance of energy as given on page 45 the computed heat production lying and standing, respectively, upon the two hypotheses indicated above—that is, if we compute the gain or loss of energy by difference—we obtain the following figures for the gain:

Computed gain lying and standing.

Period.	Gain of protein and fat.		Growth of epithelial tissue.	Correction for nitrogen.	Total gain.	
	First hypothesis.	Second hypothesis.			First hypothesis.	Second hypothesis.
LYING.	*Calories.*	*Calories.*	*Calories.*	*Calories.*	*Calories.*	*Calories.*
A	−1,418	−1,748	+88	+61	−1,269	−1,599
B	+1,094	+ 624	+88	+ 9	+1,191	+ 721
C	+2,002	+1,596	+88	+ 3	+2,093	+1,687
D	+2,415	+1,983	+88	−83	+2,420	+1.988
STANDING.						
A	−3,676	−3,431	+88	+61	−3,527	−3,282
B	−1,841	−1,621	+88	+ 9	−1,744	−1,524
C	− 911	− 597	+88	+ 3	− 820	− 506
D	− 513	− 243	+88	−83	− 508	− 238

The observed and computed results of the experiment are presented graphically upon Diagram III, in which the abscissæ represent the amounts of metabolizable energy supplied to the animal and the ordinates the resulting gain or loss of energy. Represented in this way, the angle with the horizontal made by the straight line connecting any two points will increase or decrease as the availability of the food increases or decreases, becoming 45° when the latter equals 100 per cent. Thus, comparing Periods A and B, and regarding Period A as the basal period, the distance AE on the diagram represents the amount of metabolizable energy added to the basal ration in Period B, while EB represents the extent to which the loss of tissue has been diminished thereby; that is, it represents the available energy of the added food. The percentage availability, then, will obviously be equal to $\frac{BE}{AE} = \tan BAE$.

In like manner each period has been compared with the next lower. Thus, subtracting Period A from Period B, we find that 2,840 Calories of metabolizable energy were added in the latter period, and that they diminished the loss of tissue by 1,820 Calories. The percentage availability, therefore, is $\frac{1{,}820}{2{,}840} = 64.08$ per cent. The same computations for Periods C and D, and for the lying and standing positions upon the two hypotheses stated above, give the results contained in the following tables. In the first table the average gains have been made the basis of the comparison, including in this Period C, in spite of the considerable discrepancy between the two determinations:

Availability of energy—observed results.

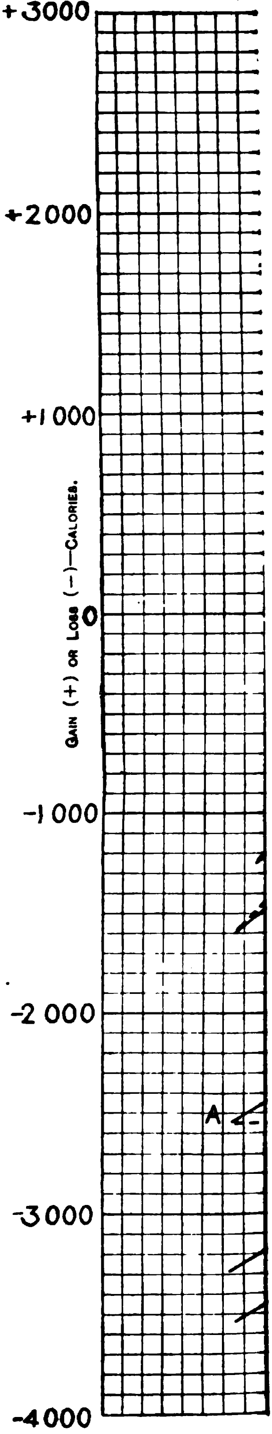
Period.	Metabolizable energy.	Gain.	Availability.
	Calories.	*Calories.*	*Per cent.*
B	9,491	− 758	
A	6,651	−2,578	
Difference	2,840	1,820	64.08
C[a]	11,198	+ 266	
B	9,491	− 758	
Difference	1,707	1,024	59.99
D	12,106	+ 571	
C[a]	11,198	+ 266	
Difference	908	305	33.59

[a] Using average gain; see p. 54.

Availability of energy—computed results.

Period.	Metabolizable energy.	First hypothesis.		Second hypothesis.	
		Gain.	Availability.	Gain.	Availability.
LYING.	*Calories.*	*Calories.*	*Per c*	*ories.*	*Per cent.*
B	9,491	[illegible]		+ 721	
A	6,651	− [illegible]		[illegible]	
Difference	2,840	[illegible]	86.62	2,320	81.69
C	11,198	+2,093		+1,687	
B	9,491	+1,191		+ 721	
Difference	1,707	902	52.84	966	56.59
D	12,106	+2,420		+1,988	
C	11,198	+2,093		+1,687	
Difference	908	327	36.02	301	33.15
STANDING.					
B	9,491	−1,744		−1,524	
A	6,651	−3,527		−3,282	
Difference	2,840	1,783	62.78	1,758	61.90
C	11,198	− 820		− 506	
B	9,491	−1,744		−1,524	
Difference	1,707	924	54.13	1,018	59.64
D	12,106	− 508		− 238	
C	11,198	− 820		− 506	
Difference	908	312	34.37	268	29.52

Both the above tables and the diagram show a close general agreement with the exception of the computed results in Period B–A, lying.


+3000
+2000
+1000
0
-1000
-2000
-3000
-4000
GAIN (+) OR LOSS (−)—CALORIES.
A

We are inclined to explain this divergence by the supposition that when the animal was lying down in Period A the relatively small amount of heat arising from the digestion and assimilation of the very light ration, together with that produced by the necessary internal work of the animal, was insufficient to maintain the body temperature, and that consequently there was a direct stimulation to the processes of heat production, resulting in a greater loss of energy by the animal than corresponded to the availability of the energy of the hay.

It is evident both from the figures and the diagram that the two hypotheses as to the rate of excretion of the water vapor standing and lying affect the final results but very slightly.

Averaging the percentage availabilities by the above methods of computation, omitting those of Period B–A, lying, we have the following results:

Average availability of energy.

	Period B–A.	Period C–B.	Period D–C.
	Per cent.	*Per cent.*	*Per cent.*
Observed	64.08	59.99	33.51
Computed, lying:			
First hypothesis	[86.62]	52.84	36.02
Second hypothesis	[81.69]	56.59	33.15
Computed, standing:			
First hypothesis	62.78	54.13	34.37
Second hypothesis	61.90	59.64	29.52
Average	62.92	56.64	33.31

As noted on page 47, it seems possible that the results for digestibility, and consequently for metabolizable energy, in Period A are somewhat too low. If we make the conjectural correction in the amount of metabolizable energy indicated on page 51, the results for Period B–A would be as follows:

	Per cent.
Observed	59.39
Computed lying:	
First hypothesis	84.87
Second hypothesis	79.30
Computed standing:	
First hypothesis	57.92
Second hypothesis	56.93

While the percentages computed in this way are somewhat lower than those calculated in the table, the differences are relatively small in themselves, and affect but very slightly the general teachings of the experiment.

During Periods A and B the results as observed show a loss of tissue by the animal, and the comparison between these two, therefore, shows the extent to which this loss was diminished by means of hay added to the ration. In Periods C and D, on the other hand, there was a gain by the animal, and the comparison between these two periods shows the extent to which the gain was increased by the addition of hay.

The results as computed standing are all below the maintenance requirement, while of those computed lying all but one are above the maintenance requirement. It seems very doubtful, however, whether the gain which is computed to have taken place while the animal was lying down represents any real formation of new tissue; that is, whether the storage of energy which appears to have taken place in these short periods is to be interpreted as an actual formation of proteid tissue and fat. It seems more probable that it was, at least largely, simply a storing up of assimilated material which was used up again as fuel when the animal stood. In other words, it seems probable that it was the amount rather than the nature of the metabolism which was affected by the position of the animal, and this view is confirmed by the general similarity of all the lines upon the diagram and of the percentages as calculated in the preceding table. Granting this, the average percentages computed in the last table may fairly be taken to represent approximately the percentage availability of the successive additions of hay.

If we take the observed results in Period A as a starting point and multiply the successive increments of metabolizable energy by the average percentages just computed, we get the figures of the following table, which may be taken as representing the average of the results of the experiment as variously computed. The same results are represented graphically in Diagram IV:

Values for energy—average results.

Period.	Metabolizable energy.	Average availability.	Computed available and gain.
	Calories.	*Per cent.*	*Calories.*
B	9,491		− 791
A	6,651		−2,578
Difference	2,840	62.92	1,7 7
C	11,198		+ 176
B	9,491		− 791
Difference	1,707	56.64	967
D	12,106		+ 478
C	11,198		+ 176
Difference	908	33.31	302

Comparing Periods A and B, we conclude, then, that the percentage availability of the metabolizable energy below the maintenance requirement was 62.92 per cent. Similarly, comparing Periods C and D above the maintenance requirement, we find that the percentage of metabolizable energy actually utilized in the formation of tissue was 33.31 per cent.

If we assume the percentage availability below maintenance and the percentage utilization above maintenance to be linear functions of the metabolizable energy, then the result obtained by comparing Periods C and D is a mixed result. In other words, the line *AB* in Diagram IV, on this hypothesis, would continue in the same direction until it intersected the zero line, from which point it would continue through *C* and *D*, making an angle with its previous course. In other words the lines *AB* and *DC* in the diagram, if produced, should intersect the zero line at the same point, and this point would indicate the maintenance requirement of the animal. We can readily compute these points of intersection as follows: Dividing the loss in Period B, 2,578 Calories, by the percentage availability, 0.6292, we have 4,097 Calories as the amount of metabolizable energy required to be added to the basal ration to exactly balance this loss. Adding to this the 6,651 Calories of the basal ration, we have a total of 10,748 Calories as the maintenance requirement. A precisely similar computation may be made from the figures of Periods C and D. The results in the two cases may be concisely tabulated as follows:

Computed maintenance requirement.

From Periods A and B.	2,578 Calories÷0.6292=4,097 Calories. 4,097 Calories+6,651 Calories=10,748 Calories.
From Periods C and D.	478 Calories÷0.3331=1,435 Calories. 12,106 Calories—1,435 Calories=10,671 Calories.

These figures show a very close agreement, and the same thing is shown also in the diagram by the production of the lines *AB* and *DC*, both of them intersecting the zero line at approximately the same point, *E*. We may fairly conclude, then, that the line *AED* in the diagram represents the law of availability in these experiments.

Strictly speaking, all the above results are subject to a correction for the varying live weight of the animal. The actual weights on the respiration days did not differ very widely, however, while we have very meager data as to the actual effect of such differences upon the metabolism. The correction would be relatively small in any case and we have thought it on the whole most satisfactory to omit it altogether.

The above results upon availability, like those upon metabolizable energy, may also be brought into relation to the total or the digestible organic matter of the feed. Taking the results for metabolizable energy per gram of organic matter, tabulated on page 50, we have simply to multiply by 0.6292 or 0.3331 to obtain, respectively, the corresponding amounts of net available energy or of energy stored as gain, as follows:

Net available energy.

Period.	Per gram of total organic matter.			Per gram of digestible organic matter.		
	Metabolizable energy.	Available energy.	Energy utilized for gain.	Metabolizable energy.	Available energy.	Energy stored as gain.
	Calories.	*Calories.*	*Calorie.*	*Calories.*	*Calories.*	*Calories.*
A	2.156	1.357	0.718	3.633	2.287	1.210
B	2.275	1.482	.758	3.736	2.352	1.245
C	2.143	1.348	.714	3.716	2.339	1.238
D	1.972	1.241	.657	3.592	2.261	1.197

Kellner[a] found for two samples of meadow hay an average utilization of 41.5 per cent of the metabolizable energy and 37.6 per cent for that of one sample of oat straw. The corresponding figures per gram of organic matter, computed in a slightly different manner, were:

Net available energy of meadow hay and oat straw.

	Meadow hay.	Oat straw.
	Calories.	*Calories.*
Per gram total organic matter	0.950	0.623
Per gram digestible organic matter	1.610	1.409

The lower figures obtained by us for timothy hay may well be ascribed to its coarser and more woody character, although, as already noted, the results are of somewhat questionable value on account of the small excess above maintenance which was consumed.

SUMMARY.

We are far from regarding the results of the experiment described in the foregoing pages as sufficiently extensive to warrant positive conclusions. On the contrary, we present them and trust that they will be regarded as simply a report of progress, and we hope to be able to check them by more extensive investigations in the future. At the same time they relate to phases of the subject which have not heretofore, so far as we are aware, been the subject of specific investigation, and we therefore feel justified in considering somewhat more fully than might otherwise be proper the indications afforded by our results, with the express statement, however, that we regard such discussion as tentative only.

ISODYNAMIC REPLACEMENT.

Rubner's well-known experiments with dogs and other animals showed that at or below the maintenance requirement nearly pure nutrients could be substituted in the metabolism of the animal for the ingredients of body tissue, and that they were valuable for this purpose approximately in proportion to their metabolizable energy as above defined. For example, Rubner found that when nearly pure proteids were given to a fasting dog the amount of proteids destroyed in the body was largely increased, but that a correspondingly smaller amount of fat was oxidized, and, further, that the proteids replaced fat in inverse proportion to their content of metabolizable energy. Under these conditions there was of course no increase in the total amount of heat produced in the body, but simply a substitution of one kind of fuel for another. Rubner experimented with fats and carbohydrates as well as with proteids and found the same law to hold, while in a single experiment he also substituted carbohydrates for fats in the food in a corresponding ratio. This substitution of nutrients in the manner just indicated is called by Rubner "isodynamic replacement" and the relative values of the nutrients as deduced from it "isodynamic values." Rubner experimented chiefly with carnivora, but his law has been generally assumed to apply to all animals. Thus Kellner,[a] in his extensive investigations upon cattle, regards the results which he obtained for the metabolizable energy of various materials as representing their value as part of the maintenance ration and speaks of them as "replacement values" (Vertretungswerte).

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[a] Landw. Vers. Stat., v. 53, p. 460.

As has already been indicated, however, it has been well established by the investigations of Zuntz and others that there is a not inconsiderable expenditure of energy in the digestion and assimilation of the food. This energy must ultimately assume the form of heat in the body, the amount of heat produced depending on the kind and amount of food consumed. This would seem to imply an increase in the heat production with increasing quantities of food, and therefore to contradict the law of isodynamic replacement. Rubner explains this apparent discrepancy by the hypothesis that the heat into which the energy expended in digestion and assimilation is ultimately converted is substituted in the body for an equivalent amount of heat which would otherwise be produced by oxidation of body substance in order to maintain the temperature of the body, so that there is no increase in the total heat production.

Rubner's conclusions have exerted a profound influence upon the science of nutrition, but at the same time their value lies quite as much in the point of view which they opened up as in their exact numerical accuracy. As just stated, isodynamic replacement implies that there is no increase in heat production with an increasing amount of food. As a matter of fact, however, the great majority of Rubner's experiments do show more or less increase in the heat production, the only exceptions being a single experiment with fat and three or four upon cane sugar, some of which Rubner himself considers of doubtful value. From theoretical considerations we had been led to question the entire applicability of Rubner's law to herbivorous animals, and especially to ruminants with their large expenditure of energy in digestive work, and the experiment here reported was planned to test the equivalence of the metabolizable energy of hay and that of body tissue.

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[a] Landw. Vers. Stat., v. 53, pp. 448–449.

The results obtained in the periods below the maintenance ration, as above reported, fully confirm this doubt. Only 63 per cent of the metabolizable energy served to prevent loss of tissue, while 37 per cent simply increased the heat production of the animal. In other words, *the digested matter of the hay was not isodynamic with body tissue under the conditions of this experiment.* Moreover, the difference is altogether too large to be ascribed to any experimental error or to be accounted for by the discrepancies in some of the results.

This difference may be reasonably ascribed to the relatively large expenditure of energy necessary in the digestion and assimilation of the hay. Even upon a comparatively light ration, this amount, in addition to the heat arising from the internal work of the body, appears to have been sufficient to maintain the normal body temperature at the comparatively high stable temperature (18.2° C.). Such being the case, when more hay was added the heat arising from its digestion and assimilation was in excess of the needs of the animal for heat and became an excretum, passing off without being of any direct service to the organism. In other words, what one of us has elsewhere designated[a] as the critical amount of food must be relatively small in the case of a material like timothy hay, which requires a large amount of digestive work. In our experiment, even the smallest amount of food seems to have been in excess of the critical amount; consequently, when more food was added the additional heat resulting from its digestion and assimilation could not be used indirectly and served simply to increase the heat production, while only the remaining 63 per cent of the metabolizable energy served as fuel for the body in place of the tissue previously consumed.

Quite recently Rubner[b] has published in book form an elaborate discussion of this question, including the results of later experiments on dogs in which amounts of fat, carbohydrates, or proteids considerably in excess of those required for the simple maintenance of the body were fed. Under these conditions, and at relatively high temperatures, he finds that all these nutrients, but especially the proteids, may cause a marked increase in the heat production of the animal. In other words, he shows that what appears to be true of ruminants below the maintenance requirement is equally true of carnivora when the amount of food consumed is relatively large. It is obvious that this result is entirely in harmony with our own, the only difference being that the critical amount of food appears to be relatively much larger with carnivora than with herbivora.

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[a] Armsby: Principles of Animal Nutrition, p. 408.

[b] Die Gesetze des Energieverbrauchs bei der Ernährung.

As already indicated, we are inclined to regard the results obtained in Period A, while the steer was lying down, as an exception to the above statements. Here we suspect the line indicating the availability of the metabolizable energy to be that indicated by the dotted lines in Diagram III. In other words, we believe that under these conditions isodynamic replacement would take place up to an amount of about 8,450 Calories of metabolizable energy, this constituting the critical amount of food when the animal was lying.

THE MAINTENANCE REQUIREMENT.

If the above conclusions are admitted, it is evident that the maintenance requirement of cattle is a question of tissue replacement rather than of heat production, and, therefore, that the value of a given feeding stuff for maintenance depends upon the availability of its energy. We may, for instance, regard it as at least very probable thaf the work of digestion and assimilation in the case of a material like corn meal would be materially less than in the case of hay; or, in other words, that a larger percentage of its energy would be available for the maintenance of tissue. It would follow from this that in case of a ration consisting largely of grain a less amount of material or of metabolizable energy would be required for maintenance than in the case of a ration consisting exclusively of coarse fodder. In other words, the maintenance ration is a variable rather than a constant, depending upon the kind of food used. It may be noted that this conclusion has already been indicated by the experiments upon the maintenance ration of cattle made at this station in 1896–97.[a]

The average maintenance requirement of our animal as computed above is 10,710 Calories. The average weight of the animal during the experiment was approximately 410 kilograms. Computing to 500 kilograms live weight on the assumption that the maintenance requirement is proportional to the two-thirds power of the live weight, this equals 12,197 Calories. Kellner's average for coarse fodders is 11,520 Calories.[b] As has just been pointed out, however, the amount of metabolizable energy required for maintenance varies with the availability of that energy. The availability of timothy hay is probably less than that of Kellner's meadow hay. Certainly the percentage utilization above maintenance as well as the percentage digestibility of the hay is less than that of Kellner's, as the above figures show. Naturally, therefore, more of it would be needed to reach the maintenance requirement.

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[a] Penn. Experiment Station Bul. No. 42, p. 159.

[b] Loc. cit., p. 13.

INFLUENCE OF EXTERNAL TEMPERATURE ON THE MAINTENANCE REQUIREMENT.

If the heat production upon the maintenance ration is in excess of the requirements of the animal, it seems unlikely that small variations in the stable temperature to which the animal is exposed will have the effect upon the maintenance requirement which is ordinarily attributed to them. Still less is this likely to be the case with fattening cattle, where the amount of food and the consequent heat production are largely in excess of the maintenance ration.

EXPENDITURE OF ENERGY IN TISSUE BUILDING.

Our results indicate that the proportion of the metabolizable energy of the food which was utilized, above the maintenance requirement, to produce gain was decidedly less than that used below the maintenance requirement to prevent loss of tissue. In other words, they indicate that the conversion of digested and assimilated matter into actual tissue (fat) requires a considerable expenditure of energy, amounting in this case to about 47 per cent of the available energy or 30 per cent of the metabolizable energy. This result is quite in accordance with what we should anticipate. The digested matter of the food of herbivora appears to be resorbed chiefly in the form of carbohydrates and of organic acids. It seems altogether probable that a much less profound change is required to convert these resorbed products into forms suited to maintain the energy metabolism of the organism than is needed to convert them into the form of permanent tissue, especially fat. At the same time it should be noted that the amount of food given in excess of the maintenance requirement in this experiment was small and, moreover, that the results in Period C are somewhat doubtful. We do not feel, therefore, that very much stress should be laid upon the apparent results of this experiment in this particular.

INFLUENCE OF THE AMOUNT OF FOOD.

It has been commonly assumed that the percentage availability of the energy of a food, within reasonable limits, is unaffected by its amount, or, in other words, that the available energy is a linear function of the metabolizable energy. The plan of our experiments contemplated the feeding of three rations less than the maintenance ration. Unfortunately the results show that the ration of Period C was slightly in excess of the maintenance requirement and consequently we have only two points below that amount. The general agreement among themselves, however, of the results computed on the assumption that the availability is a linear function seems to afford considerable evidence in favor of this view, although it can not be said to demonstrate it, and the same may be said of the percentage utilization above maintenance so far as any conclusions can be drawn from the small gains observed.

We should anticipate that the muscular work of digestion would be approximately proportional to the dry matter supplied. As the figures show, the proportion of the total energy of the hay which was found to be metabolizable diminished as the amount was increased, the difference arising chiefly from differences in digestibility. Since, nevertheless, the total expenditure of energy in digestion and assimilation appears to be approximately proportional to the metabolizable energy, it seems evident that a large share of this expenditure must be for the work of assimilation. Probably a very large factor in it is the loss of energy in the methane fermentation.

COMPOSITION OF COMBUSTIBLE GASES.

The results upon the ratio of hydrogen to carbon in the combustible gases contained in the outgoing air current, as given on page 32, show that with this animal, under the conditions of this experiment, these gases consisted substantially of methane.

APPENDIX.

TABLE I.—*Weight, water drunk, and excreta.*

For 24 hours ended on date given.	Live weight.	Water drunk.	Feces.	Urine.[a]
HAY ONLY.				
Steer No. 1.				
Dec., 1901.	*Kilos.*	*Kilos.*	*Grams.*	*Grams.*
10......	444.4	15.8	14,280	3,230
11......	448.0	18.0	13,380	3,460
12......	448.0	14.0	14,520	3,700
13......	444.4	17.0	12,860	4,240
14......	442.0	21.4	14,670	[b][3,220]
15......	446.2	15.6	13,380	3,780
16......	444.0	17.0	14,500	3,490
17......	443.4	17.6	15,020	[b][1,570]
18......	444.0	15.4	11,710	3,840
19......	444.0	18.0	13,080	[b][3,490]
Steer No. 2.				
Dec., 1901.				
10......	442.6	0.4	9,890	3,000
11......	430.0	30.0	9,095	3,670
12......	446.0	0.0	10,340	[b][2,260]
13......	429.2	34.2	10,260	5,740
14......	448.8	0.0	10,330	4,410
15......	432.8	27.4	9,850	4,100
16......	445.2	0.0	11,150	3,620
17......	433.0	28.0	9,550	4,060
18......	442.9	0.0	14,650	2,970
19......	431.0	20.0	9,080	3,860
MIXED RATIONS.				
Steer No. 1.				
Period A:				
Mar., 1902.				
26......	418.0	0.9	....	....
27......	405.2	22.4	....	....
28......	412.2	0.4	....	....
29......	399.6	19.4	....	....
30......	407.0	6.1	....	....
31......	398.2	8.7	....	....
Apr., 1902.				
1......	396.8	10.8	....	....
2......	....	1.9	6,090	3,660
3......	[c]396.8	16.6	7,175	4,585
MIXED RATIONS.				
Steer No. 1.				
Period A:				
Apr., 1902.	*Kilos.*	*Kilos.*	*Grams.*	*Grams.*
4......	388.2	3.4	6,780	....
5......	382.5	13.8	6,335	3,298
6......	385.0	9.2	6,640	2,760
7......	384.8	11.2	5,875	2,605
8......	384.8	8.9	6,217	3,798
Total	....	....	45,112	20,706
2, spilled	....	....	64.1	554
5, spilled	....	....	14.3	....
Period B:				
Feb., 1902.				
23......	414.8	15.4	....	....
24......	414.0	12.0	....	....
25......	411.4	14.0	....	....
26[d]	....	8.0	....	....
27......	410.2	17.2	....	....
28......	412.4	6.0	....	....
Mar., 1902.				
1......	399.6	22.8	....	....
2......	410.4	10.4	....	....
3......	406.7	8.8	....	....
4......	404.4	11.6	....	....
5......	....	9.5	10,105	3,205
6......	[e]407.3	10.6	6,800	2,637
7......	394.5	20.1	8,464	3,075
8......	403.2	9.6	9,192	2,614
9......	400.5	18.5	7,477	[f]2,495
10......	407.3	6.6	9,825	2,960
11......	402.5	18.2	7,842	2,690
Total	....	....	59,705	19,696
Spilled in calorimeter......	....	....	565	....
Period C:				
Mar., 1902.				
12......	411.1	12.3	....	....
13......	410.3	19.2	....	....

[a] Including preservative and wash water.

[b] Some loss. No sample taken.

[c] When removed from calorimeter at 6 p. m.

[d] In calorimeter for preliminary test.

[e] When removed from calorimeter at 6 p. m.

[f] A very small quantity of urine lost.

TABLE I.—*Weight, water drunk, and excreta*—Continued.

For 24 hours ended on date given.	Live weight.	Water drunk.	Feces.	Urine.[a]
MIXED RATIONS.				
Steer No. 1.				
Period C:				
Mar., 1902.	*Kilos.*	*Kilos.*	*Grams.*	*Grams.*
14	415.3	15.1	....	....
15	414.8	18.9	....	....
16	418.0	13.8	....	....
17	414.5	19.3	....	....
18	416.8	14.6	....	....
19	....	15.3	13,075	3,441
20	[b] 423.8	14.8	14,048	3,103
21	411.5	22.2	12,395	3,979
22	416.5	12.5	13,378	3,825
23	411.8	23.4	12,250	4,505
24	417.6	15.6	12,785	3,820
25	414.8	24.2	11,565	4,210
Total	....	....	89,496	26,883
Spilled in calorimeter	....	....	149	467.8
Spilled in stall	....	....	117.6	....

For 24 hours ended on date given.	Live weight.	Water drunk.	Feces.	Urine.[a]
MIXED RATIONS.				
Steer No. 1.				
Period D:				
Apr., 1902.	*Kilos.*	*Kilos.*	*Grams.*	*Grams.*
9	385.1	25.6	....	....
10	401.9	14.7	....	....
11	401.2	22.4	....	....
12	409.0	22.4	....	....
13	414.8	18.0	....	....
14	413.5	23.7	....	....
15	417.9	18.6	....	....
16	....	20.1	17,520	4,675
17	[c] 431.8	19.1	15,268	4,275
18	416.5	29.9	16,208	4,549
19	424.2	21.5	16,232	4,125
20	424.1	23.4	16,597	4,327
21	425.2	19.8	17,413	4,365
22	423.6	23.9	17,054	4,180
Total	....	....	116,292	30,496
Spilled in calorimeter	....	....	42.1	....

[a] Including preservative and wash water.

[b] At 6 p. m. on leaving calorimeter.

[c] On leaving calorimeter at 6 p. m.

TABLE II.—*Composition of dry matter of feces.*

Constituents and energy.	Hay only.		Mixed rations.			
	Steer No. 1.	Steer No. 2.	Period A.	Period B.	Period C.	Period D.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ash	5.97	5.97	6.25	6.19	6.07	6.15
Protein (N×6.25)	7.26	7.08	7.57	7.47	7.26	7.11
Crude fiber	36.72	36.70	37.49	35.43	37.58	39.20
Nitrogen-free extract	46.94	47.14	46.23	48.06	46.48	44.92
Ether extract	3.11	3.11	2.46	2.85	2.61	2.62
	100.00	100.00	100.00	100.00	100.00	100.00
Total nitrogen	1.161	1.133	1.212	1.196	1.163	1.137
Proteid nitrogen	....	....	.914	1.033	1.016	.872
Pepsin-insoluble nitrogen	....	....	.985	.973	.973	.903
Carbon	....	....	48.585	49.330	48.682	48.460
			Calories per gram.	*Calories per gram.*	*Calories per gram.*	*Calories per gram.*
Heat of combustion	....	....	4.809	4.930	4.866	4.831

TABLE III.—*Digestibility of rations.*

Ration.	Dry matter.	Ash.	Organic matter.	Proteids.	Non-proteids.	Crude fiber.	N.-free extract.	Ether extract.	Nitrogen.	Carbon.	Energy.
HAY ONLY.											
Steer No. 1.	*Gms.*	*Gms.*	*Gms.*	*Grams.*		*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Grams.*	*Cals.*
Hay	5,986.3	277.8	5,708.5	304.7		2,330.0	2,949.3	124.5	48.73	....	27,262
Feces	2,579.0	154.0	2,425.0	187.2		947.0	1,210.6	80.2	29.94	....	12,872
Digested	3,407.3	123.8	3,283.5	117.5		1,383.0	1,738.7	44.3	18.79	....	14,390
Coefficients, p.ct.	56.92	44.56	57.52	38.56		59.35	58.95	35.58	38.56	....	52.78
Steer No. 2.											
Hay	4,788.9	222.2	4,566.7	243.7		1,863.8	2,359.6	99.6	38.98	....	21,869
Feces	2,078.7	124.1	1,954.6	147.2		762.8	979.9	64.7	23.55	....	10,231
Digested	2,710.2	98.1	2,612.1	96.5		1,101.0	1,379.7	34.9	15.43	....	11,578
Coefficients, p.ct.	56.60	44.15	57.20	39.62		59.07	58.46	35.04	39.62	....	53.09
MIXED RATIONS.											
Steer No. 1 only.											
Period A:											
Hay	2,879.5	133.3	2,746.2	136.5	7.5	1,112.1	1,427.6	62.5	23.4	1,337.6	13,035
Linseed meal	357.8	19.1	338.7	111.5	8.8	31.9	149.9	36.6	22.2	172.5	1,824
Total	3,237.3	152.4	3,084.9	248.0	16.3	1,144.0	1,577.5	99.1	45.6	1,510.1	14,859
Feces	1,337.4	83.6	1,253.8	101.2	....	501.4	618.3	32.9	16.2	649.8	6,432
Digested	1,899.9	68.8	1,831.1	146.8	16.3	642.6	959.2	66.2	29.4	860.3	8,427
Coefficients, p.ct.	58.69	45.14	59.36	59.19	100.00	56.17	60.80	66.80	....	....	56.71
Period B:											
Hay	4,018.0	182.8	3,835.2	192.5	8.0	1,546.9	1,995.8	92.0	32.5	1,876.8	18,463
Linseed meal	354.7	18.7	336.0	110.6	9.2	30.8	149.3	36.1	22.1	170.7	1,811
Total	4,372.7	201.5	4,171.2	303.1	17.2	1,577.7	2,145.1	128.1	54.6	2,047.5	20,274
Feces	1,739.1	107.6	1,631.5	129.9	....	616.2	835.8	49.6	20.8	858.0	8,574
Digested	2,633.6	93.9	2,539.7	173.2	17.2	961.5	1,309.3	78.5	33.8	1,189.5	11,700
Coefficients, p.ct.	60.23	46.60	60.89	57.15	100.00	60.94	61.04	61.28	....	....	57.76
Period C:											
Hay	5,124.3	235.7	4,888.6	241.9	8.7	1,972.8	2,554.0	111.2	40.6	2,366.9	23,321
Linseed meal	356.1	19.3	336.8	108.8	9.2	32.9	150.0	35.9	21.8	172.5	1,814
Total	5,480.4	255.0	5,225.4	350.7	17.9	2,005.7	2,704.0	147.1	62.4	2,539.4	25,135
Feces	2,354.3	142.9	2,211.4	170.9	....	884.7	1,094.3	61.5	27.4	1,146.1	11,456
Digested	3,126.1	112.1	3,014.0	179.8	17.9	1,121.0	1,609.7	85.6	35.0	1,393.3	13,679
Coefficients, p.ct.	57.05	43.96	57.68	51.27	100.00	55.89	59.53	58.19	....	....	54.42
Period D:											
Hay	6,085.8	284.2	5,801.6	326.8	19.5	2,361.9	2,937.0	156.4	56.4	2,831.7	27,727
Linseed meal	354.4	19.0	335.4	107.6	11.1	32.6	147.6	36.5	21.9	172.6	1,811
Total	6,440.2	303.2	6,187.0	434.4	30.6	2,394.5	3,084.6	192.9	78.3	3,004.3	29,538
Feces	2,948.3	181.3	2,767.0	209.6	....	1,155.7	1,324.4	77.3	33.5	1,428.7	14,243
Digested	3,491.9	121.9	3,370.0	224.8	30.6	1,238.8	1,760.2	115.6	44.8	1,575.6	15,295
Coefficients, p.ct.	54.22	40.22	54.92	51.75	100.00	51.74	57.06	59.93	....	....	51.78

TABLE IV.—*Results on urine.*

Period.	Weight.	Average specific gravity.	Total nitrogen.		Total carbon.		Energy.	
							Per gram.	Total.
	Grams.		*Per ct.*	*Grams.*	*Per ct.*	*Grams.*	*Calories.*	*Calories.*
Period A:								
Total collected	20,706	1.0366	1.047	216.79	2.540	525.9	0.2457	5,087
Spilled in calorimeter	554	....	.207	1.15	[a].502	2.8	[a].0486	27
Total	21,260	....	....	217.94	....	528.7	....	5,114
Daily average (6 days)	3,543	....	....	36.32	....	88.1	....	853
Period B:								
Total collected	19,696	1.0463	1.197	235.86	3.60	709.1	.3430	6,756
Daily average (7 days)	2,814	....	....	33.69	....	101.3	....	965
Period C:								
Total collected	26,883	1.0417	.879	236.30	3.03	814.6	.2860	7,689
Spilled	468	....	.535	2.50	[a]1.84	8.6	[a].1741	81
Total	27,351	....	....	238.80	....	823.2	....	7,770
Daily average (7 days)	3,907	....	....	34.11	....	117.6	....	1,110
Period D:								
Total collected	30,496	1.0396	.744	226.89	2.85	869.1	.2778	8,472
Daily average(7 days)	4,357	....	....	32.41	....	124.2	....	1,210

[a] Assumed to be proportional to nitrogen content.

TABLE V.—*Residual air.*

Period.	Aspirator reading.[a]	Barometer.	Temperature.	Weight of—		Corresponding volume at 0° and 760 mm.		Total volume of sample reduced.		Volume of moist air in chamber reduced.	Total in chamber of—	
				Water.	Carbon dioxide.	Water.	Carbon dioxide.	Dry.	As sampled.		Water.	Carbon dioxide.
Period A.	*Liters*	*Mm.*	*°C.*	*Gms.*	*Gms.*	*Liters*	*Liters*	*Liters*	*Liters*	*Liters*	*Gms.*	*Gms.*
At beginning of subperiod 1.	25	719.8	18.0	......	0.0878	[b]0.16	0.04	21.77	21.93	10,888	.....	43.6
At beginning of subperiod 2.	25	719.8	18.0	0.1329	.0901	.16	.04	21.77	21.93	10,888	66.0	44.7
At beginning of subperiod 3.	25	721.8	18.0	.1175	.0944	.15	.04	21.84	21.99	10,918	58.3	46.9
At beginning of subperiod 4.	25	725.7	18.5	.1088	.0907	.14	.04	21.90	22.04	10,977	54.2	45.2
At end of subperiod 4	25	727.5	19.1	.1635	.0974	.20	.05	21.91	22.11	11,004	81.4	48.5
Period B.												
At beginning of subperiod 1.	25	727.4	17.8	.1605	.0995	.19	.05	22.04	22.23	11,008	79.5	49.3
At beginning of subperiod 3.	25	720.9	17.7	.1550	.1043	.19	.06	21.85	22.04	10,677	75.1	50.5
At end of subperiod 4	25	732.7	17.9	.1338	.1116	.16	.05	22.15	22.31	10,604	63.7	53.1
Period C.												
At beginning of subperiod 1.	25	734.0	17.0	.1131	.1262	.14	.07	22.35	22.49	11,102	55.8	62.3
At beginning of subperiod 2.	25	733.9	16.4	.1349	.1050	.16	.05	22.40	22.56	11,101	66.3	51.7
At beginning of subperiod 3.	25	725.6	17.0	.1277	.1124	.16	.06	22.08	22.24	10,930	62.8	55.2
At beginning of subperiod 4.	25	726.5	18.2	.1470	.1132	.19	.06	21.98	22.17	10,990	72.9	56.1
At end of subperiod 4	25	727.6	15.4	.1715	.1044	.21	.05	22.26	22.47	11,007	84.0	51.1
Period D.												
At beginning of subperiod 1.	25	731.5	19.5	.1593	.1235	.20	.06	22.00	22.20	11,065	79.4	61.6
At beginning of subperiod 2.	25	731.6	17.8	.1515	.1231	.18	.06	22.18	22.36	11,066	75.0	60.9
At beginning of subperiod 3.	25	727.5	20.1	.1297	.1282	.16	.06	19.57	19.73	11,004	72.3	71.5
At beginning of subperiod 4.	25	726.6	17.8	.1543	.1170	.18	.06	22.07	22.25	10,991	76.2	57.8
At end of subperiod 4	25	725.3	19.4	.1266	.1171	.16	.06	21.88	22.04	10,971	63.0	58.3

[a] Assumed to be saturated with aqueous vapor. [b] Assumed correction.

TABLE VI.—*Ventilation.*

Period.	Volume at meter pump.	Average barometer.	Average tension of aqueous vapor.	Average temperature.	Reduced volume at meter pump, dry.	Sample for residual air, dry.	Methane produced.	Volume of entering air, dry.
Period A.	*Liters.*	*mm.*	*mm.*	° *C.*	*Liters.*	*Liters.*	*Liters.*	*Liters.*
Subperiod 1	480,350	719.8	1.75	14.77	430,542.5	10.9	[52.1]	430,501.3
Subperiod 2	488,400	721.8	1.29	15.1	438,754.4	21.8	52.7	438,723.5
Subperiod 3	488,000	725.5	1.15	15.0	440,896.7	21.9	52.9	440,865.7
Subperiod 4	488,000	727.2	1.17	16.2	440,073.4	32.9	50.7	440,055.6
Period B.								
Subperiod 1	468,100	727.4	1.36	13.4	426,358.6	11.0	61.7	426,307.9
Subperiod 2	471,800	720.9	1.35	14.0	424,881.6	10.9	64.8	424,827.7
Subperiod 3	479,400	724.1	1.34	13.9	433,920.1	10.9	73.4	433,857.6
Subperiod 4	488,000	730.4	1.20	15.0	443,812.8	11.1	63.9	443,759.4
Period C.								
Subperiod 1	483,600	734.0	1.31	13.6	444,105.4	33.5	66.1	444,072.8
Subperiod 2	492,200	728.3	1.11	14.2	447,697.6	22.2	73.0	447,646.9
Subperiod 3	489,600	726.8	1.21	15.3	442,607.9	22.0	78.7	442,551.2
Subperiod 4	487,350	727.7	1.11	15.0	441,711.2	33.3	72.0	441,672.5
Period D.								
Subperiod 1	483,200	731.6	1.75	15.8	438,613.8	22.2	99.3	438,536.8
Subperiod 2	485,100	729.7	1.74	16.2	442,750.6	19.57	96.9	442,673.3
Subperiod 3	484,500	727.0	1.93	16.5	435,887.3	22.07	102.4	435,807.0
Subperiod 4	483,450	726.6	1.74	16.8	434,459.5	21.9	101.2	434,380.2

TABLE VII.—*Ingoing air.*

Period.	Aspirator reading.	Barometer.	Temperature.	Reduced aspirator reading dry.	Volume of carbon dioxide.	Total volume of sample, reduced and dry.	Ratio of sample to total ventilation.	Water.		Carbon dioxide.	
								In sample.	In total ventilation.	In sample.	In total ventilation.
Period A.	*Liters*	*mm.*	° *C.*	*Liters.*	*Liter.*	*Liters.*	*1:*	*Gram.*	*Grams.*	*Gram.*	*Grms.*
Subperiod 1	200	719.8	19.8	172.88	0.05	172.94	2,489.5	0.3155	785.5	0.1145	285.1
Subperiod 2	200	721.8	19.5	173.55	.05	173.60	2,527.5	.1760	444.9	.1095	276.8
Subperiod 3	200	725.5	20.0	174.31	.05	174.36	2,528.5	.2330	589.1	.1080	273.1
Subperiod 4	200	727.5	20.8	174.13	.05	174.18	2,526.5	.1450	366.3	.0975	246.3
Period B.											
Subperiod 1	200	726.0	18.2	175.73	.05	175.78	2,425.4	.5715	1,386.3	.1100	266.8
Subperiod 2	200	720.0	17.9	174.46	.07	174.53	2,434.2	.4220	1,027.2	.1375	334.7
Subperiod 3	200	728.0	17.4	177.15	.05	177.20	2,448.5	.1660	406.5	.1045	255.9
Subperiod 4	200	732.7	21.0	175.42	.04	175.46	2,529.1	.0655	165.7	.0965	244.1
Period C.											
Subperiod 1	200	733.9	19.0	177.00	.05	177.05	2,508.2	.2320	582.0	.1045	262.1
Subperiod 2	200	725.6	19.2	174.85	.05	174.9	2,559.4	.1965	502.9	.1015	259.8
Subperiod 3	200	726.5	20.2	174.47	.05	174.52	2,535.8	.2490	631.4	.1075	272.6
Subperiod 4	200	727.6	19.4	175.32	.05	175.37	2,518.5	.1915	482.3	.1045	263.2
Period D.											
Subperiod 1	200	731.6	20.2	175.35	.06	175.41	2,500.0	.3980	995.0	.1170	292.5
Subperiod 2	200	727.5	20.5	174.12	.05	174.17	2,541.6	.2680	681.2	.1035	263.1
Subperiod 3	200	726.6	19.4	174.88	.05	174.93	2,491.3	.1660	413.6	.1090	271.6
Subperiod 4	200	725.3	21.8	172.86	.05	172.91	2,512.2	.1015	255.0	.1050	263.8

TABLE VIII.—*Carbon dioxide.*

Period.	Carbon dioxide in samples (corrected).[a]		Total, Nos. 1 and 2 × 100.	In sample of residual air.	Correction for residual air.	Total CO_2 in outcoming air.	Total CO_2 in ingoing air.	CO_2 added in chamber.	Equivalent carbon.
	Pan No. 1.	Pan No. 2.							
Period A.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Subperiod 1	9.799	9.724	1,952.4	0.05	+ 1.1	1,953.5	285.1	1,668.4	455.0
Subperiod 2	10.013	9.975	1,998.8	.09	+ 2.2	2,001.1	276.8	1,724.3	470.3
Subperiod 3	9.915	9.866	1,978.1	.09	− 1.7	1,976.5	273.1	1,703.4	464.5
Subperiod 4	9.935	10.033	1,996.8	.14	+ 3.3	2,000.2	246.3	1,753.9	478.3
Period B.									
Subperiod 1	11.345	11.328	2,267.3	.05	....	2,267.4	266.8	2,000.6	545.6
Subperiod 2	11.160	11.117	2,227.7	.05	+ 1.22	2,229.0	334.7	1,894.3	516.6
Subperiod 3	11.471	11.525	2,299.6	.05	....	2,299.7	255.9	2,043.8	557.4
Subperiod 4	10.924	10.985	2,190.9	.06	+ 2.6	2,193.5	244.1	1,949.4	531.6
Period C.									
Subperiod 1	12.574	12.483	2,505.7	.18	−10.6	2,495.3	262.1	2,233.2	609.0
Subperiod 2	12.036	11.999	2,403.5	.11	+ 3.6	2,407.2	259.8	2,147.4	585.6
Subperiod 3	12.380	12.368	2,474.9	.11	+ .88	2,475.9	272.6	2,203.3	600.9
Subperiod 4	12.112	12.094	2,420.6	.16	− 5.0	2,415.8	263.2	2,152.6	587.1
Period D.									
Subperiod 1	13.312	13.318	2,663.0	.12	− .7	2,662.5	292.5	2,370.0	646.4
Subperiod 2	13.068	13.007	2,607.5	.13	+10.6	2,618.2	263.1	2,355.1	642.4
Subperiod 3	13.322	13.397	2,671.9	.12	−13.7	2,658.3	271.6	2,386.7	651.0
Subperiod 4	13.081	13.028	2,610.9	.12	+ .5	2,611.6	263.8	2,347.8	640.4

[a] For number of pump strokes, see page 30.

TABLE IX.—*Water.*

Period.	Water in samples (corrected)[a].		Total, Nos. 1 and 2×100.	In cans.	Drip water and absorbers.	In sample of residual air.	Correction for residual air.	Total H_2O in outcoming air +absorbers.	Total H_2O in ingoing air.	Water added in chamber.	Equivalent hydrogen.
	Pan No. 1.	Pan No. 2.									
Period A.	*Gms.*	*Gms.*	*Gms.*	*Grams.*	*Gms.*	*Gms.*	*Gms*	*Grams.*	*Gms.*	*Grams.*	*Grams.*
Subperiod 1.....	4.233	4.229	846.2	1,755.0	0	0.07	....	2,601.2	785.5	1,815.7	201.8
Subperiod 2.....	3.183	3.191	637.4	1,904.0	0	.13	− 7.7	2,533.8	444.9	2,088.9	232.1
Subperiod 3.....	2.829	2.824	565.3	2,066.0	0	.11	− 4.1	2,627.3	589.1	2,038.2	226.5
Subperiod 4.....	2.866	2.856	572.2	1,823.0	0	.22	+27.2	2,422.6	366.3	2,056.3	228.5
Period B.											
Subperiod 1.....	3.257	3.239	649.6	2,700.0	−10	.08	....	3,339.7	1,386.3	1,953.4	217.0
Subperiod 2.....	3.191	3.217	640.8	2,445.0	0	.08	− 4.42	3,081.4	1,027.2	2,054.2	228.3
Subperiod 3.....	2.696	2.759	545.5	2,088.0	0	.08	....	2,633.5	406.5	2,227.0	247.5
Subperiod 4.....	2.921	2.944	586.5	1,618.0	0	.07	−11.4	2,193·1	165.7	2,027.4	225.3
Period C.											
Subperiod 1.....	3.237	3.242	647.9	2,151.0	0	.18	+10.5	2,809.6	582.0	2,227.7	247.5
Subperiod 2.....	2.735	2.734	546.9	2,135.0	0	.13	- 3.6	2,678.5	502.9	2,175.6	241.7
Subperiod 3.....	2.975	2.971	594.6	2,292.0	0	.14	+10.1	2,896.9	631.4	2,265.5	251.7
Subperiod 4.....	2.711	2.711	542.2	2,305.0	0	.25	+11.1	2,858.6	482.3	2,376.3	264.0
Period D.											
Subperiod 1.....	4.280	4.238	851.8	2,444.0	0	.15	− 4.4	3,291.5	995.0	2,296.5	255.2
Subperiod 2.....	4.255	4.240	849.5	2,067.0	0	.13	− 2.6	2,914.0	681.2	2,232.8	248.1
Subperiod 3.....	4.702	4.705	940.7	1,946.0	0	.15	+ 3.9	2,890.7	413.6	2,477.1	275.2
Subperiod 4.....	4.237	4,226	846.3	1,774.0	0	.13	−13.2	2,607.3	255.0	2,352.3	261.4

[a] For number of pump strokes, see page 30.

TABLE X.—*Carbon and hydrogen in combustible gases.*

Period.	Total CO_2 weighed ×200.	Equivalent carbon.	Correction for ingoing air.	Carbon as hydrocarbon.	Total H_2O weighed ×200.	Equivalent hydrogen.	Correction for ingoing air.	Hydrogen as hydrocarbon.	Methane CO_2 ×.3643
Period A.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Subperiod 1.....	....	....	....	....	....	....	....	....	....
Subperiod 2.....	103.96	28.350	0.215	28.135	87.02	9.737	0.055	9.682	37.58
Subperiod 3.....	104.17	28.408	.215	28.193	85.93	9.616	.055	9.561	37.66
Subperiod 4.....	99.89	27.240	.215	27.025	84.35	9.438	.055	9.383	36.12
Period B.									
Subperiod 1.....	121.41	33.108	.207	32.901	99.89	11.177	.056	11.121	43.99
Subperiod 2.....	127.48	34.765	.207	34.558	103.70	11.603	.056	11.547	46.16
Subperiod 3.....	144.22	39.328	.215	39.113	117.64	13.163	.056	13.107	52.23
Subperiod 4.....	125.68	34.272	.215	34.057	104.47	11.689	.056	11.663	45.50
Period C.									
Subperiod 1.....	129.97	35.440	.215	35.225	109.72	12.278	.055	12.223	47.06
Subperiod 2.....	143.44	39.115	.221	38.894	119.23	13.341	.056	13.285	51.93
Subperiod 3.....	154.57	42.150	.218	41.932	127.60	14.281	.055	14.226	56.02
Subperiod 4.....	141.63	38.625	.215	38.410	116.56	13.042	.056	12.986	51.31
Period D.									
Subperiod 1.....	198.82	54.220	1.301	52.919	166.00	18.574	1.269	17.305	70.69
Subperiod 2.....	194.23	52.965	1.312	51.653	160.47	17.955	1.265	16.690	69.01
Subperiod 3.....	204.90	55.875	1.293	54.582	168.76	18.882	1.261	17.621	72.92
Subperiod 4.....	202.55	55.238	1.287	53.951	166.82	18.610	1.257	17.353	72.07

TABLE XI.—*Heat measurements.*

Period.	Relative rate of flow.	Average temperature of water current.					Total water.	Average specific heat of water.	Heat produced in absorbers.		Total heat, Calories at 20°.
		Ingoing.	Outcoming.	Difference.	Correction for pressure.	Corrected difference.			Difference of pressure.	Equivalent heat.	
PERIOD A.											
Subperiod 1.		°C.	°C.	°C.	°C.	°C.	*Liters.*		*Cm.*	*Cals.*	
6 p. m. to 6.50 p. m	31	7.9584	10.767	2.809	+0.006	2.815	86.00	1.0032	3.12	0.09	242.69
6.50 p. m. to 7.30 p. m..	32	7.847	10.383	2.536	+ .007	2.543	75.00	1.0033	3.75	.09	191.26
7.30 p. m. to 1.38 a. m..	33	7.301	9.556	2.2551	+ .009	2.2641	826.68	1.0037	4.37	1.15	1,877.75
1.38 a. m. to 6 a. m	33	6.7200	8.5123	1.7923	+ .009	1.8013	586.32	1.0041	4.37	.81	1,058.49
											3,370.19
Latent heat of water vapor..............	......	......	......	......	......	......	......	......	......	......	1,074.92
Corrections for feed, water, excreta, vessels, etc............	......	......	......	......	......	......	......	......	......	......	−6.33
Total heat.......	......	......	......	......	......	......	......	......	......	......	4,438.78
Subperiod 2.											
6 a. m. to 6.50 a. m	33	6.608	9.027	2.419	+ .009	2.428	112.00	1.0040	4.37	.16	272.85
6.50 a. m. to 6 p. m	35	6.296	8.015	1.719	+ .010	1.729	1,878.00	1.0044	5.63	3.35	3,258.00
											3,530.85

TABLE XI.—*Heat measurements*—Continued.

Period.	Relative rate of flow.	Average temperature of water current.					Total water.	Average specific heat of water.	Heat produced in absorbers.		Total heat, Calories at 20°.
		Ingoing.	Outcoming.	Difference.	Correction for pressure.	Corrected difference.			Difference of pressure.	Equivalent heat.	
PERIOD A—Continued.											
Subperiod 2—Cont'd.											
		°C.	°C.	°C.	°C.	°C.	Liters.		Cm.	Cals.	
Latent heat of water vapor											1,236.63
Corrections for feed, etc											+19.63
Total heat											4,787.11
Subperiod 3.											
6 p. m. to 9.06 p. m	35	6.149	7.936	1.787	+0.010	1.797	520.00	1.0044	5.63	0.93	937.62
9.06 p. m. to 3.02 a. m	33	6.126	7.998	1.872	+ .009	1.881	794.00	1.0044	4.37	1.10	1,498.99
3.02 a. m. to 6 a. m	35	5.977	8.067	2.090	+ .010	2.100	481.10	1.0044	5.63	.86	1,013.89
											3,450.50
Latent heat of water vapor											1,206.61
Corrections for feed, etc											−7.46
Total heat											4,649.65
Subperiod 4.											
6 a. m. to 3.58 p. m	35	6.022	7.810	1.788	+ .010	1.798	1,610.10	1.0045	5.63	2.88	2,903.66
3.58 p. m. to 4.10 p. m	33	6.153	7.903	1.750	+ .009	1.759	29.00	1.0044	4.37	.04	51.20
4.10 p. m. to 5.02 p. m	32	6.270	8.304	2.034	+ .007	2.041	96.00	1.0043	3.75	.11	196.67
5.02 p. m. to 6 p. m	35	6.124	8.188	2.064	+ .010	2.074	158.00	1.0044	5.63	.28	328.85
											3,480.38
Latent heat of water vapor											1,217.33
Corrections for feed, etc											+2.86
Total heat											4,700.57
Total for period											18,576.11
Average per day											9,288.06
PERIOD B.											
Subperiod 1.											
6 p. m. to 6.03 p. m	28	5.530	11.250	5.720	+ .002	5.722	2.61	1.0039			14.99
6.03 p. m. to 1.14 a. m	29	4.814	9.136	4.322	+ .003	4.325	543.00	1.0045	2.00	.34	2,358.70
1.14 a. m. to 5.10 a. m	30	4.171	8.299	4.128	+ .004	4.132	357.00	1.0050	2.50	.28	1,482.22
5.10 a. m. to 6 a. m	28	4.378	8.988	4.610	+ .002	4.612	41.50	1.0047	1.50	.02	192.28
											4,048.19
Latent heat of water vapor											1,156.51
Corrections for feed, etc											−30.72
Total heat											5,173.98

TABLE XI.—*Heat measurements*—Continued.

Period.	Relative rate of flow.	Average temperature of water current.					Total water.	Average specific heat of water.	Heat produced in absorbers.		Total heat, Calories at 20°.
		Ingoing.	Outcoming.	Difference.	Correction for pressure.	Corrected difference.			Difference of pressure.	Equivalent heat.	
PERIOD B—Continued.											
Subperiod 2.		°C.	°C.	°C.	°C.	°C.	*Liters.*		*Cm.*	*Cals.*	
6.00 a. m. to 6.02 a. m.	28	......	......	5.380	+0.002	5.382	1.66	1.0051	......	......	8.98
6.02 a. m. to 9.26 a. m.	30	3.959	7.897	3.938	+ .004	3.942	322.34	1.0051	2.50	0.39	1,276.59
9.26 a. m. to 1.18 p. m.	28	4.257	9.190	4.933	+ .002	4.935	206.00	1.0046	1.50	.10	1,021.10
1.18 p. m. to 6.00 p. m.	29	3.920	8.368	4.448	+ .003	4.451	395.50	1.0050	2.00	.23	1,768.78
											4,075.45
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,216.11
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	+57.29
Total heat	....	......	......	......	......	......	......	......	......	......	5,348.85
Subperiod 3.											
6.00 p. m. to 11.54 p. m.	29	3.893	8.294	4.401	+ .003	4.404	452.75	1.0050	2.00	.30	2,003.63
11.54 p. m. to 6.00 a. m.	29	3.678	8.612	4.934	+ .003	4.938	422.00	1.0050	2.00	.25	2,093.79
											4,097.42
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,318.39
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	+0.53
Total heat	....	......	......	......	......	......	......	......	......	......	5,416.34
Subperiod 4.											
6.00 a. m. to 9.30 a. m.	29	3.560	8.276	4.716	+ .003	4.719	248.00	1.0053	2.00	.16	1,176.30
9.30 a. m. to 3.14 p. m.	28	4.252	9.033	4.781	+ .002	4.783	308.50	1.0048	1.50	.15	1,482.55
3.14 p. m. to 4.22 p. m.	29	4.587	9.408	4.821	+ .003	4.824	84.50	1.0046	2.00	.05	409.47
4.22 p. m. to 6.00 p. m.	30	4.650	8.513	3.863	+ .004	3.867	146.25	1.0048	2.50	.18	568.05
											3,636.37
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,200.24
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	13.31
Total heat	....	......	......	......	......	......	......	......	......	......	4,849.92
Total for period	....	......	......	......	......	......	......	......	......	......	20,789.09
Average per day	....	......	......	......	......	......	......	......	......	......	10,394.55
PERIOD C.											
Subperiod 1.											
6.15 p. m. to 1.18 a. m.	32	5.560	7.954	2.394	+ .007	2.401	916.00	1.0046	3.75	1.09	2,208.43
1.18 a. m. to 6.15 a. m.	33	4.421	7.177	2.756	+ .009	2.765	706.75	1.0051	4.37	.98	1,963.22
											4,171.65
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,318.80
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	+4.57
Total heat	....	......	......	......	......	......	......	......	......	......	5,495.02

TABLE XI.—*Heat measurements*—Continued.

Period.	Relative rate of flow.	Average temperature of water current.					Total water.	Average specific heat of water.	Heat produced in absorbers.		Total heat, Calories at 20°.
		Ingoing.	Outcoming.	Difference.	Correction for pressure.	Corrected difference.			Difference of pressure.	Equivalent heat.	
PERIOD C—Continued.											
Subperiod 2.		°C.	°C.	°C.	°C.	°C.	*Liters.*		*Cm.*	*Cals.*	
6.15 a. m. to 9.30 a. m.	33	4.026	6.597	2.571	+0.009	2.580	453.00	1.0054	4.37	0.63	1,174.33
9.30 a. m. to 9.38 a. m.	32	4.010	6.305	2.295	+ .007	2.302	19.00	1.0055	3.75	.02	43.92
9.38 a. m. to 2.02 p. m.	31	4.131	7.093	2.962	+ .006	2.968	428.00	1.0053	3.12	.42	1,276.53
2.02 p. m. to 6.15 p. m.	33	4.437	7.097	2.660	+ .009	2.669	599.25	1.0052	4.37	.83	1.606.89
											4,101.67
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,287.93
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	+24.81
Total heat	....	......	......	......	......	......	......	......	......	......	5,414.41
Subperiod 3.											
6.15 p. m. to 11.34 p. m.	33	3.972	6.330	2.358	+ .009	2.3668	753.00	1.0054	4.37	1.04	1,790.78
11.34 p. m. to 12.02 a. m.	32	3.923	6.189	2.266	+ .007	2.2727	57.00	1.0055	3.75	.07	130.17
12.02 a. m to 4.02 a. m.	31	4.127	7.118	2.991	+ .006	2.9967	410.00	1.0052	3.12	.41	1,234.59
4.02 a. m. to 6.15 a. m.	33	4.038	6.944	2.906	+ .009	2.9154	314.00	1.0053	4.37	.44	919.96
											4,075.50
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,341.15
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	−6.38
Total heat	....	......	......	......	......	......	......	......	......	......	5,410.27
Subperiod 4.											
6.15 a. m. to 8.10 a. m.	33	4.101	6.657	2.556	+ .009	2.5649	276.00	1.0054	4.37	.38	711.47
8.10 a. m. to 11.50 a. m.	31	4.515	7.474	2.959	+ .006	2.9653	350.00	1.0050	3.12	.35	1,043.65
11.50 a. m. to 12.06 p. m.	32	4.685	8.040	3.355	+ .007	3.3620	29.00	1.0048	3.75	.03	97.93
12.06 p. m. to 3.38 p. m.	33	4.634	7.223	2.589	+ .009	2.5975	511.00	1.0051	4.37	.71	1,333.29
3.38 p. m. to 6.15 p. m.	31	4.928	7.676	2.748	+ .006	2.7545	254.00	1.0049	3.12	.25	702.80
											3,889.14
Latent heat of water vapor	....	......	......	......	......	......	......	......	......	......	1,406.77
Corrections for feed, etc	....	......	......	......	......	......	......	......	......	......	+12.96
Total heat	....	......	......	......	......	......	......	......	......	......	5,308.87
Total for period	....	......	......	......	......	......	......	......	......	......	21,628.57
Average per day	....	......	......	......	......	......	......	......	......	......	10,814.29
PERIOD D.											
Subperiod 1.											
6.00 p. m. to 7.22 p. m.	45	6.911	8.728	1.817	+ .024	1.841	300.00	1.0040	13.43	1.18	553.32
7.22 p. m. to 7.34 p. m.	43	6.853	8.713	1.860	+ .021	1.881	37.00	1.0040	12.17	.14	69.73
7.34 p. m. to 7.50 p. m.	45	6.825	8.645	1.820	+ .024	1.844	50.00	1.0041	13.43	.20	92.37
7.50 p. m. to 8.10 p. m.	47	6.786	8.548	1.762	+ .027	1.789	86.00	1.0041	14.60	.40	154.08
8.10 p. m. to 8.42 p. m.	50	5.380	7.491	2.111	+ .031	2.142	127.00	1.0048	16.36	.64	272.74
8.42 p. m. to 1.08 a. m.	45	5.279	6.795	1.516	+ .024	1.540	967.32	1.0050	13.43	3.81	1,492.99

TABLE XI.—*Heat measurements*—Continued.

Period.	Relative rate of flow.	Average temperature of water current.					Total water.	Average specific heat of water.	Heat produced in absorbers.		Total heat. Calories at 20°.
		Ingoing.	Outcoming.	Difference.	Correction for pressure.	Corrected difference.			Difference of pressure.	Equivalent heat.	
PERIOD D—Continued.											
Subperiod 1—Cont'd.		°C.	°C.	°C.	°C.	°C.	*Liters.*		*Cm.*	*Cals.*	
1.08 a. m. to 2.13 a. m..	29	5.806	11.389	5.583	+0.003	5.586	32.68	1.0037	2.00	0.02	183.19
2.13 a. m. to 3.00 a. m..	29	3.310	9.209	5.899	+ .003	5.902	57.25	1.0050	2.00	.04	339.56
3.00 a. m. to 6.00 a. m..	45	4.854	6.434	1.580	+ .024	1.604	799.50	1.0052	13.43	3.15	1,285.85
											4,443.83
Latent heat of water vapor	....	....	....	....	....	....	....	....	....	......	1,359.54
Corrections for feed, etc	....	....	....	....	....	....	....	....	....	......	−5.68
Total heat	....	....	....	....	....	....	....	....	....	......	5,797.69
Subperiod 2.											
6.00 a. m. to 6.22 a. m...	45	3.9750	5.3667	1.3916	+ .024	1.4156	114.00	1.0058	13.43	.45	161.86
6.22 a. m. to 9.36 a. m...	42	4.4094	5.8089	1.3996	+ .021	1.4206	936.00	1.0056	11.50	3.41	1,333.99
9.36 a. m. to 12.30 p. m..	40	5.2705	6.3884	1.1179	+ .018	1.1359	781.00	1.0051	10.00	2.47	889.19
12.30 p. m. to 3.26 p. m..	42	4.7350	6.0620	1.3270	+ .021	1.3480	830.72	1.0054	11.50	3.02	1,122.84
3.26 p. m. to 3.42 p. m..	40	5.5475	6.4950	.9475	+ .018	.9655	87.00	1.0050	10.00	.27	84.13
3.42 p. m. to 3.58 p. m...	39	5.6625	6.6675	1.0050	+ .018	1.0230	52.00	1.0049	9.12	.15	53.29
3.58 p. m. to 4.06 p. m...	37	5.730	6.810	1.080	+ .014	1.094	41.00	1.0048	7.37	.10	44.96
4.06 p. m. to 4.22 p. m...	35	5.800	7.028	1.228	+ .010	1.238	50.00	1.0047	5.63	.10	62.07
4.22 p. m. to 5.18 p. m...	33	5.751	7.351	1.599	+ .009	1.608	142.00	1.0047	4.37	.20	229.24
5.18 p. m. to 6.00 p. m...	40	5.962	7.277	1.315	+ .018	1.333	194.75	1.0046	10.00	.62	260.18
											4,241.75
Latent heat of water vapor	....	....	....	....	....	....	....	....	....	......	1,321.76
Corrections for feed, etc	....	....	....	....	....	....	....	....	....	......	+146.37
Total heat	....	....	....	....	....	....	....	....	....	......	5,709.88
Subperiod 3.											
6.00 p. m. to 1.26 a. m..	40	6.246	7.541	1.295	+ .018	1.313	1,998.00	1.0045	10.00	6.34	2,626.06
1.26 a. m. to 1.42 a. m..	42	6.355	7.837	1.482	+ .021	1.503	81.00	1.0044	11.50	.30	121.98
1.42 a. m. to 1.58 a. m..	43	6.360	7.782	1.422	+ .021	1.443	67.00	1.0044	12.17	.26	96.86
1.58 a. m. to 4.22 a. m..	45	6.370	7.488	1.118	+ .024	1.142	742.00	1.0045	13.43	2.92	848.28
4.22 a. m. to 4.30 a. m..	43	6.380	7.790	1.410	+ .021	1.431	39.00	1.0044	12.17	.15	55.91
4.30 a. m. to 6.00 a. m..	45	6.180	7.485	1.305	+ .024	1.329	456.50	1.0045	13.43	1.80	607.60
											4,356.69
Latent heat of water vapor	....	....	....	....	....	....	....	....	....	......	1,466.44
Corrections for feed, etc	....	....	....	....	....	....	....	....	....	......	+7.70
Total heat	....	....	....	....	....	....	....	....	....	......	5,830.83
Subperiod 4.											
6.00 a. m. to 9.26 a. m..	40	6.0558	7.3258	1.270	+ .018	1.288	1,060.00	1.0046	10.00	3.36	1,368.14
9.26 a. m. to 2.14 p. m..	42	6.430	7.520	1.090	+ .020	1.110	1,310.00	1.0044	11.50	4.77	1,455.33
2.14 p. m. to 2.26 p. m..	45	6.7766	8.1132	1.3366	+ .024	1.3606	66.00	1.0042	13.43	.24	89.96
2.26 p. m. to 6.00 p. m..	47	6.290	7.495	1.205	+ .027	1.232	1,102.75	1.0045	14.69	5.14	1,359.66
											4,273.09

TABLE XI.—*Heat measurements*—Continued.

Period.	Relative rate of flow.	Average temperature of water current.					Total water.	Average specific heat of water.	Heat produced in absorbers.		Total heat, Calories at 20°.
		Ingoing.	Outcoming.	Difference.	Correction for pressure.	Corrected difference.			Difference of pressure.	Equivalent heat.	
PERIOD D—Continued.											
Subperiod 4—Cont'd.											
		°C.	°C.	°C.	°C.	°C.	*Liters.*		*Cm.*	*Cals.*	
Latent heat of water vapor											1,392.56
Corrections for feed, etc											+54.83
Total heat											5,720.48
Total for period											23,058.88
Average per day											11,529.44

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[Continued from second page of cover.]

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